SEDIMENT-WATER NUTRIENT FLUX IN TIDAL CREEKS OF NORTH INLET, SOUTH CAROLINA

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Michael Duane Quillen

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Director of Thesis

Master's Committee: , Chairman

Lloyd R. Jaisingh

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Date

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Michael D. Quillen, M.S.
Morehead State University, 1992

Director of Thesis: ______________________

Sediment-water nutrient flux was analyzed in tidal creeks of North Inlet, South Carolina. Three tidal creeks were studied with different geological ages, as well as different zones within those tidal creeks. Nutrients studied included PO_4^{-3}, NO_3^-, NH_4^+, and D.O.C. Additionally, two chamber designs were implemented; one to measure advective nutrient flux, and a second to measure diffusive flux.

Data collected in tidal creeks in North Inlet showed that all three tidal creek types exported nutrients. Oyster Landing, a geologically young tidal creek, exported all nutrients studied during both flood and ebb tides. Ammonia and D.O.C. were the largest exports during both tidal phases. Within Oyster Landing, the marsh zones exported the largest amounts of nutrients, followed by the bank and creek zones; however, total export from these three zones was not significantly different (α=.10). Advective nutrient flux was greater from the creek zones, followed by the bank and marsh zones. Nutrient flux measured by the two chamber designs was not significantly different (α=.10).

Nutrient flux in No Man's Friend, an intermediate age tidal creek, was highly variable. Nutrients were exported during flood tide, and imported during ebb tide. Overall, marsh zones in No Man's Friend imported nutrients, while bank and creek zones exported nutrients. Nutrient flux measured in benthic and advective flow chambers was not significantly

different, and values of net export in this site were intermediate between Oyster Landing and Town Creek.

Town Creek, a geologically old tidal creek, exhibited the smallest nutrient export in North Inlet. All nutrients studied were exported from this site during both flood and ebb tide. The creek zones released the largest percentage of nutrients, followed by the bank and marsh zones. Mean nutrient flux from these three zones, and both chamber types, were not significantly different (α=.10).

Overall, tidal creeks in North Inlet exported all nutrients studied. Dissolved organic carbon was the largest export in North Inlet, at 2,446.92 µg-at m^{-2} $tide^{-1}$. Ammonia export was second in magnitude, at 687.53 µg-at m^{-2} $tide^{-1}$. Total export of PO_4^{-3} was small, at 248.18 µg-at m^{-2} $tide^{-1}$. Total export of NO_3^- was 42.65 µg-at m^{-2} $tide^{-1}$, exhibiting the smallest nutrient flux in North Inlet. Total nutrient flux in the three geological age tidal creeks was significantly different in North Inlet (α=.10). However, nutrient flux measured by benthic and advective flux chambers was not significantly different, although nutrient flux in benthic chambers was typically greater (α=.10).

Accepted by: Bjorn C. Dale________, Chairman

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CHAPTER I
INTRODUCTION

Since the work of Odum and de la Cruz in 1967, estuarine salt marshes have been investigated as possible exporters of nutrients to adjacent continental shelves. It was proposed that, because estuarine salt marshes were highly productive, they produce an excess of nutrients which are "outwelled" and contribute to productivity in coastal shelf ecosystems.

Mass balance studies have been conducted in several estuarine salt marshes in North America to examine the "outwelling hypothesis." Nixon (1980) concluded, from a summary of work done over a twenty-year period, that salt marshes export nutrients; however, their net export was small. Much work has been done to determine possible sources of nutrients in salt marsh ecosystems (Chrzanowski et al. 1982; Childers and Day 1988; Dame et al. 1986).

Results of riverine and watershed imput studies suggested that an internal source of nutrients existed. Woodwell and Whitney (1977) found that phosphate uptake was highest in the winter, and lowest in the summer. This suggested that plant uptake is not the dominant mechanism of phosphorus uptake. Several studies made to locate the internal source concentrated on the vegetated marsh surface (Gardner 1989; Whiting et al. 1989). Results from these studies suggested that the marsh surface was not the source of nutrients. In all studies, the possible contribution of tidal creeks was largely ignored. Since tidal creeks constitute a large area within estuarine salt marshes, these areas may contribute to import and export of nutrients (Whiting and Childers 1989; Reeder et al., in press).

Since North Inlet is a transgressive estuary, tidal creeks form as a result of the flooding of forested coastal uplands (Gardner and Bohn 1980; Dame et al. 1992); therefore, geologic age can be estimated. The tidal creeks closest to the forested boundary are geologically young, while tidal creeks adjacent to the ocean are geologically old. Three tidal creek types, based on geologic age, exist in North Inlet. The types are recognized as young, intermediate, and old tidal creeks (Reeder et al. in press). This project has several specific goals.

1. To determine sediment type and nutrient availability in three tidal creeks with different ontogenies.

2. To determine net flux of nutrients in each tidal creek type, and utilize that information to determine total nutrient flux in North Inlet.

3. To develop specific methods to examine the effect of benthic remineralization and advective flow of nutrients in tidal creeks.

4. To examine nutrient flux within each tidal creek type as a result of benthic remineralizaton and advective flow.

5. To examine different regions within tidal creeks as possible sources and sinks of nutrients.

6. To determine the possible contribution of different age tidal creeks to total nutrient movement in North Inlet.

Because three tidal creeks will be examined with different ontogenies, inferences can be made concerning the effect of geologic age on nutrient cycling in tidal creeks.

Additionally, different regions can be examined as possible sources and sinks of nutrients within each tidal creek type. The following hypotheses will be tested in this study.

1. Geologically young tidal creeks sequester nutrients; geologically old tidal creeks release nutrients. (proposed in Dame et al. (1992)).

2. Direction of tidal flow significantly affects nutrient dynamics in tidal creeks; nutrients will be exported during flood tide, and imported during ebb tide.

3. The marsh zone, within each tidal creek, will export nutrients; creek and bank zone will import nutrients.

4. Advective release of nutrients will be higher than benthic remineralization of nutrients.

5. North Inlet will export nutrients from the tidal creek systems.

CHAPTER II

LITERATURE REVIEW

Salt Marsh Location

Tidal salt marshes occur in mid-latitudes and high-latitudes along intertidal shores of most continents. They are located near river mouths, in bays, and in protected lagoons (Mitsch and Gosselink 1986). In North America, salt marshes are located along the eastern seaboard and along the northern coastlines of the western states. North American marsh ecosystems are maintained in areas with a tidal range of 1-3 meters (Teal 1986); they are protected from high energy wave action by offshore sand bars and spits. The distribution of salt marshes is restricted to coastal areas flooded at high tide. Therefore, a gently sloping topographic gradient is essential to salt marsh formation and maintenance (Chapman 1960).

Salt marshes show a complex pattern of nutrient cycling; cycling is driven by a variable hydrologic regime. Hydrology determines community structure and function in the salt marsh ecosystem and in adjacent areas. Because of tidal action and seawater inundation, salt marsh inhabitants are adapted to periods of drying, submergence, temperature variations, and salinity extremes (Mitsch and Gosselink 1986). Although the level of physiologic stress is high, salt marshes are among the most productive ecosystems in the world. Productivity may be as high as 2,500 g C m^{-2} for *Spartina*, the dominant vegetation type in estuarine salt marshes (Neiring and Warner 1977).

Zonation Patterns in Estuarine Salt Marshes

Estuarine salt marshes consist of two main regions, upper marsh and lower marsh, defined by hydrologic regime (Mitsch and Gosselink 1986). Upper marsh regions are irregularly flooded by tides, and are completely exposed to the air for at least ten days a year. The upper region ranges from low marsh zone to the forested watershed, and contains predominantly saline tolerant species, such as *Juncus* and short forms of *Spartina*. Low marsh regions, in contrast, are flooded daily, and are predominantly inhabited by *Spartina alternifolia* and *S. patens*. The most notable feature of a low marsh region is the presence of tidal creeks (Mitsch and Gosselink 1986).

Whiting et al. (1987) divided an estuarine salt marsh in North Inlet, S.C., into four definable regions. The area of this 34 km^2 salt marsh consists of 70% vegetated marsh, 23% sub-tidal creek bottom, 4% oyster bar, and 3% mudflat. The vegetated marsh included both upper and lower marsh areas that were covered with vegetation. Because sub-tidal creek bottom was determined to be all creek basins constantly covered with water, the stated percentage of tidal creek zone may be an underestimation.

Tidal Creek Structure

Tidal creeks are the most notable features of estuarine salt marshes (Mitsch and Gosselink 1986). The tidal creeks are dendritic in nature, and interconnect large expanses of salt marsh. Tidal creeks occur predominantly in low marsh areas; they serve as hydrologic and nutrient conduits to all areas in the marsh (Reeder et al., in press). Salinity in tidal creeks is similar to that of the connected bay or ocean; depth fluctuates according to oceanic water level (Mitsch and Gosselink 1986).

Tidal Creek Formation

Chapman (1960) proposed that estuarine tidal creeks form as the result of "irregularities in the sediments causing water to be deflected into definite channels." Two models have been offered to explain tidal creek formation; the Mudge-Davis Model, and the Shaler Model (Gardner and Bohn 1980). The Mudge-Davis model proposes that tidal creeks form as coastal areas slowly submerge due to sea level rise, and marshes encroach on formerly terrestrial environments. Tidal creek sediments formed in this way should be terrestrial in nature, and are overlain with high marsh sediments such as those described in North Inlet (Gardner 1980).

The Shaler model proposes the formation of offshore spits or bars that, in turn, produce a protected bay or lagoon. Such an embayment protects the coast from high-energy wave action, leaving a low-energy depositional zone in the protected area. Gardner (1980) hypothesized that increased sedimentation in the bay increases elevation and decreases inundation; sedimentation permits colonization by low marsh grasses. The presence of grasses further increases sedimentation and decreases inundation; thus, allowing for colonization by high marsh grasses. Gardner (1980) found that, in North Inlet, salt marsh sediments were pre-holocine beach sediments that were overlain by fine lagoon sediments; then overlain by low marsh sediments followed by high marsh sediments. This finding was in accordance with predictions derived from Mudge-Davis formation patterns. In summary, tidal creeks formed according to the Shaler model develop under marine conditions; tidal creeks formed according to the Mudge-Davis model develop under terrestrial conditions, and later become oceanic.

Evolution of Tidal Creeks

An evolutionary progression, or succession, can be seen in estuarine tidal creeks (Gardner 1980). Young creeks are characterized by having shallow depths and a small cross-sectional area. The young creeks are typically high in silt or sand (Wolaver and Spurrier 1988); silt and sand being the products derived from previously eroded beach sediments. In the early stages of formation, tidal energy is high and wave action erodes sandy sediments, replacing them with clays and silts. As these areas accumulate organic matter from the adjacent salt marsh, tidal creek substrata becomes higher in silts and clays, and bulk density decreases.

The Mudge-Davis model of tidal creek formation predicts that, as tidal creeks are increasingly inundated with large volumes of sea water, they adjust their hydraulic geometry to accommodate increased water volume (Gardner 1980). Hydraulic adjustment includes widening and deepening of the creek basin, and growth in both amplitude and wavelength of stream meanders. Once creeks mature, they cease to migrate, and meander amplitude and wavelength reaches a maximum. In North Inlet, S.C., Gardner (1980) found that mature creeks are characterized by a lack of terrestrial boundaries; cross sectional area is typically high (>100 meters); basin morphometry is smooth. Additionally, sediments in mature creeks are typically silty mud, with a low bulk density.

Salt Marsh Function

Hydrology

Hydrology is the major factor controlling all ecological processes in wetland ecosystems (Gosselink and Turner 1978). Hydrology in salt marshes is primarily controlled by a lunar-driven, semi-diurnal tide, in addition to winds and upland storm events. The lunar-driven tide can be separated into two distinct periods: flood tide and ebb tide.

Flood tide occurs as water level increases in the ocean adjacent to salt marshes, and water flows into a series of tidal creeks. Water moves up the tidal creeks, reaching most areas in the marsh. At the apex of flood tide, creeks overflow their banks and cover marsh sediments and vegetation with nutrient-poor seawater. During ebb tide, oceanic water level decreases and drains the marsh system as water moves through the tidal creeks. Water on the marsh surface either runs off the marsh surface, or seeps through the sediments and moves back into the creeks.

Seepage occurs as pore water in marsh sediments drains through inconsistences in the sediments (Whiting et al. 1987; Whiting and Childers 1989). Pore water re-enters tidal creeks through tidal creek banks; it passes through nutrient rich sediments. Whiting and Childers (1989) proposed that this pathway may contribute significantly to nutrient movement in salt marsh ecosystems.

Pulse-type hydrologic flow, controlled by tides, influences every facet of nutrient cycling in salt marshes. High energy currents, that occur during flood tide, scour and suspend sediments; they can carry significant amounts of sediments and organic matter through the marsh system. When the flooding waters overflow creek banks, deposition occurs; deposition contributes to marsh accretion. Since the flood-tide water is usually devoid of nutrients, it can serve as an exchange medium for nutrients encountered in marsh and tidal creek sediments. These nutrients may be desorbed into flood-tide water, and be exported out of the marsh system.

Nutrient Dynamics

Several authors (Woodwell et al. 1977; Wolaver and Spurrier 1988; Dame et al. 1991) proposed that marsh type, sediment type, and vegetation were the most important factors determining if a marsh system was a source or sink of nutrients for coastal shelf ecosystems. Additionally, Dame and Gardner (1992) included landscape position, in reference to oceanic and watershed inputs, as an important factor contributing to nutrient flux. Soil type and hydraulic conductivity influence nutrient dynamics at the sediment-water interface (Bradly and Morris 1990; Whiting and Childers 1989), and may contribute to nutrients in the water column. Although not specifically stated, one can also conclude that geological age strongly influences nutrient dynamics in estuarine salt marshes.

Nakata (1989) suggested that most nutrients entering an estuarine salt marsh are absorbed by suspended sediments, then deposited as turbation decreases. During high tides turbulent flow may transport sediments. Tides, winds, and waves also affect sedimentation rate; therefore, they affect nutrient absorption and desorption. Absorption would be highest during flood tide, correlated with the period of highest tidal velocity and greatest contact between nutrients and suspended sediments. Pomeroy (1970) suggested that any excess nutrients in an estuary result from exchange of nutrients absorbed on clay minerals in the sediments. Absorption and desorption between suspended sediments and the water column has been suggested as an internal source for nutrients in a marsh system (Wolaver et al. 1984).

Craft et al. (1991) proposed that young marshes have a lower organic content and a smaller percent of carbon in the organic matter, when compared to old marshes. This phenomenon was first proposed by Vitousek and Reiners (1975); they contended that, as an ecosystem matures, the ability to conserve nutrients increases. This conclusion was further supported by Dame and Gardner (1992); they suggested that young systems sequester nutrients while mature systems release nutrients. Spurrier and Kjerfve (1988) found that Bly Creek, S.C., a young tidal creek system, functioned as a sink for nutrients such as nitrite and nitrate. Older systems, such as Town Creek, S.C., exported nutrients such as ortho-phosphate, ammonia, and carbon to the adjacent ocean (Dame et al. 1991).

Nutrients

Nitrogen

Nitrogen is often considered the limiting nutrient in marine-dominated ecosystems (Mitsch and Gosselink 1986). Concentrations of nitrogen are typically high in salt marsh sediments, but low in interstitial water; values range from 5 to 20 g N m^{-2} (Nixon 1980). As a result, most of the nitrogen is buried in the sediments; little is available for plant uptake.

Nitrogen entering a tidal salt marsh can follow many different pathways. It is fixed by bacteria, taken up by plants, buried in the sediments, and transformed or exported to the adjacent continental shelf (Mitsch and Gosselink 1986; Nixon 1980). Figure 2.1 shows a typical nitrogen cycle in salt marshes.

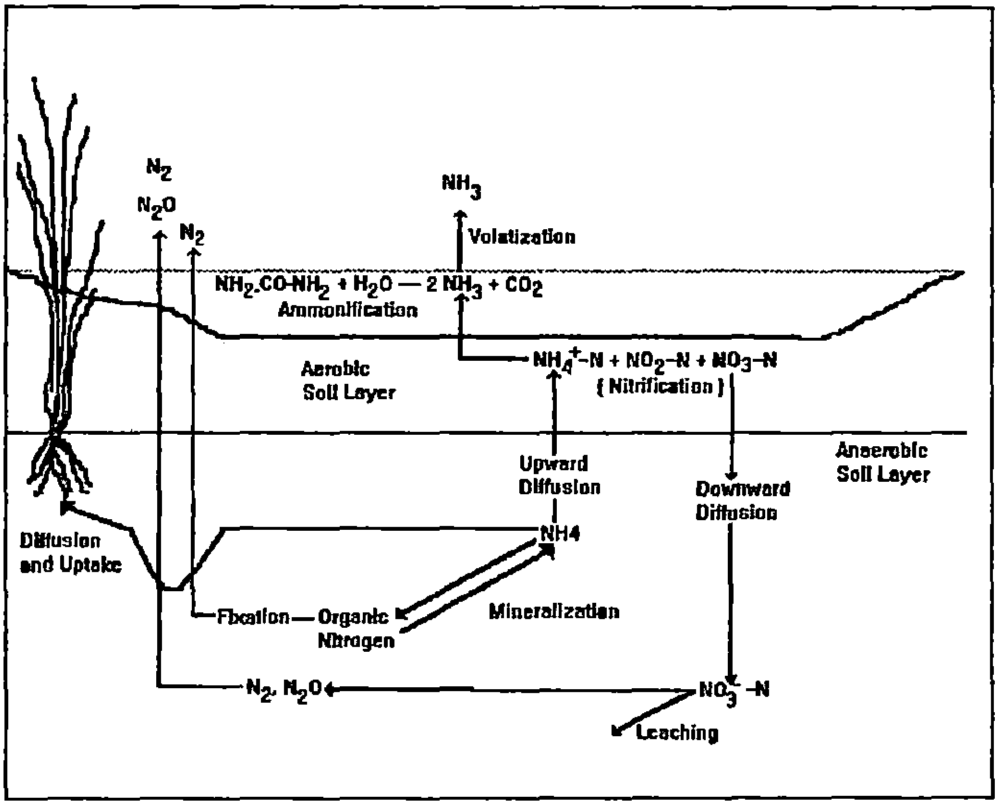

Figure 2.1.Nitrogen cycle in salt marshes. Adapted from Mitsch and Gosselink (1986).

Typically, nitrogen enters the salt marsh system as the result of decomposition of plant material, the action of nitrogen fixation by bacteria, and as urea present in animal waste. Very little nitrogen is imported to the marsh system by oceanic water (Whiting et al. 1987; Wolaver et al. 1988). Most nitrogen produced in the marsh system is recycled, and only a small amount is exported to the adjacent ocean during ebb tide (see Table 2.1). The source of these exported nutrients may be the advection, or seepage, from marsh sediments into tidal creeks (Whiting et al. 1987), with a contribution being made by nitrification within the creek itself.

Table 2.1. Nitrogen flux in salt marshes of eastern North America. Units are g N m^{-2} y^{-1}. Positive values indicate import to the marsh from the ocean. Modified from Nixon (1980).

LOCATION	NH_4^+	NO_2^-	NO_3^-	AGE	REFERENCE
G. Sipperwissett, MA	-4.2	-.1	-3.8	Old	Valiela et al. (1978)
Flax Pond, NY	-2.0	-1.2	+1.0		Woodwell et al. (1979)
Rhode River, MD	-1.3	-0.34 both			Jordan et al. (1983)
Gott's Marsh, MD	-0.4	0.0	-0.9		Heinle & Flemer (1976)
Ware Creek, VA	-2.9	-0.1	+2.3		Axelrad (1974)
Crommett Creek, NH	-2.1	-0.32 both			Daly & Matheson (1986)
North Inlet, SC	-4.7	0.58 (both)			Whiting et al. (1987)
Bly Creek, SC.	-0.65	0.23 (both)		Young	Wolaver et al. (1987)
Canary Creek, DE	+0.7	+1.9 both			Lotrich et al. (1979)
Carter Creek, VA	-0.3	0	+0.3		Axelrad (1974)

Studies conducted in a variety of salt marsh systems throughout the United States indicate that ammonia (NH_4^+) is typically exported from the system, while nitrate and nitrite import/export is variable. In all instances, net flux of these nutrients is small. The only comparison of geologic age with nutrient cycling has been made by comparing G. Siperwissett Marsh (Valiela et al. 1978) and Bly Creek, S.C. (Wolaver et al. 1987). G.

Sipperwissett marsh is a geologically old system, and tends to import all species of nitrogen. In contrast, Bly Creek, S.C., is a geologically young system; it imports NH_4^+, but exports nitrate and nitrite. However, net flux in both systems is very low, indicating that internal cycling predominates in all these systems.

Phosphorus

Phosphorus, in addition to nitrogen, is one of the more important nutrients controlling productivity in estuarine salt marshes (Mitsch and Gosselink 1986; Whitney et al. 1981). The most readily bioavailable form of phosphorus in the water column is ortho-phosphate. Ortho-phosphate can occur as PO_4^{-3} in high pH environments, as HPO_4^{-2} in moderately reducing areas, and as H_2PO_4 in strongly reducing areas. These soluble inorganic forms are very important to plant productivity; they are absorbed more readily than organic or highly mineralized forms (Wolaver and Spurrier 1988).

Phosphorus can enter the salt marsh system from animal excretion and breakdown of organic matter. Phosphorus entering tidal creek systems is quickly taken up by phytoplankton, or quickly removed from the water column by complex formation with calcium; it may be also adsorbed onto negatively charged clay particles. Guantilaka (1982) proposed a direct relationship between ortho-phosphate and suspended sediments. He found that ortho-phosphate is readily adsorbed on $CaCO_3$ sediments. This calcite coupling is significant, and may account for as much as 80% of the phosphorus initially absorbed by sediments.

Once the phosphorus is bound to clay particles, or complexed with calcium, it can settle out of solution and become permanently buried in the sediments; it may also be exported from the system in tidal action. If this phosphorus is buried in the sediments, reducing conditions could re-mobilize it and render it soluble in pore water. Redox indirectly affects phosphorus mobility in anoxic sediments. As redox potential drops, phosphorus is released. In this reduced form, phosphorus may be taken up by plants, or transported out of the sediments by seepage or advecton. Additionally, tidal creeks may serve as a significant source, or sink, of phosphorus through absorption-desorption processes (Dame et al. 1991). Particulate and dissolved phosphorus fractions may represent a major export of this nutrient from salt marsh systems (see Table 2.2).

In addition to mass movement of absorbed phosphorus, a fraction of this nutrient may leave the marsh system through desorption into tidal creek water and subsequent export to the adjacent continental shelf (Wolaver et al. 1984; Wolaver and Spurrier 1988). Further, phosphorus may be exported from the marsh sediments by advection and seepage (Whiting and Childers 1989). Hopkinson (1988) estimated that phosphorus export may be as high as 537 μmoles m^{-2} day^{-1} in salt marshes, and may contribute significantly to nutrient concentrations in coastal shelf ecosystems (Table 2.2).

Mass balance studies in estuarine salt marshes indicate that, overall, tidal salt marsh systems export ortho-phosphate. Most sites recorded in Table 2.2 export phosphorus, although the magnitude of flux is small. Additionally, a comparison can be made between geologically young and old systems.

TABLE 2.2. Phosphorus concentrations in estuarine salt marshes of Southern North America. Units are g P m^{-2} y^{-1}. Positive values indicate import to the system. Modified from Nixon (1980).

LOCATION	PO_4^{-3}	AGE	REFERENCE
Town Creek, SC	-1.7	OLD	Dame et al. (1986)
Marsh in VA	.46	YOUNG	Wolaver & Spurrier (1988)
Great Sippewissett, MA	-0.6		Valiela et al. (1978)
Flax Pond, NY	-1.4		Woodwell & Whitney (1977)
Canary Creek, DE	-0.1		Lotrich et al. (1979)
Ware Creek, VA	-0.1		Axelrad (1974)
Carter Creek, VA	-0.6		Axelrad (1974)
Dill Creek, SC	-6.4		Settlemyer & Gardner (1975)

Town Creek, S.C., considered a geologically old tidal salt marsh, exported phosphorus at the rate of 1.7 g P m^{-2} yr^{-1}. Wolaver and Spurrier (1988) investigated a geologically young salt marsh in Virginia. This young system imported phosphorus at the rate of 0.46 g P m^{-2} yr^{-1}; it showed the only net import of this nutrient in the studies listed. However, Wolaver et al. (1988) found that phosphorus was exported from Bly Creek, S.C., another geologically young system. Childers and Day (1990) examined Fourleague Bay, an intermediate age system; they found that this system exported both phosphorus and carbon. Since phosphorus export was characteristic of most systems, geologically young, intermediate, and old, it is concluded that this nutrient is typically exported from estuarine salt marshes.

Carbon

Carbon primarily enters salt marsh ecosystems through fixation of CO_2 by plants and mass loading of particulate organic matter in the form of *Spartina* wrack (Mitsch and Gosselink 1986). Once carbon is fixed by the plants, the plants die at the end of the season, and contribute to the total particulate fraction of carbon, or they are buried in the sediments. There are two major fates for particulate carbon: it can be broken down in the creeks or sediments to produce soluble forms, or it can be exported from the marsh during ebb tide. Figure 2.3 shows a typical carbon cycle in salt marshes.

Several authors have suggested that exportation of carbon is characteristic; they note that significant wracks of *Spartina* leave the mouths of estuaries on ebb tides and during storm events (Heinle and Flemer 1976). However, most of the leaves and readily degradable plant material are broken down before the wracks leave the system; they suggest a high decomposition rate of carbon in tidal creeks.

Particulate organic carbon can be broken down through the process of fermentation, a process in which organic carbon is utilized as the terminal electron acceptor in anaerobic respiration, and forms low molecular weight acids and alcohols. Weibe et al. (1981) suggested that "fermentation plays a central role in providing substrata for other anaerobes in sediments in waterlogged soils." Valiela (1984) further suggested that fermentation provides significant amounts of dissolved organic carbon, which may be utilized by microbes.

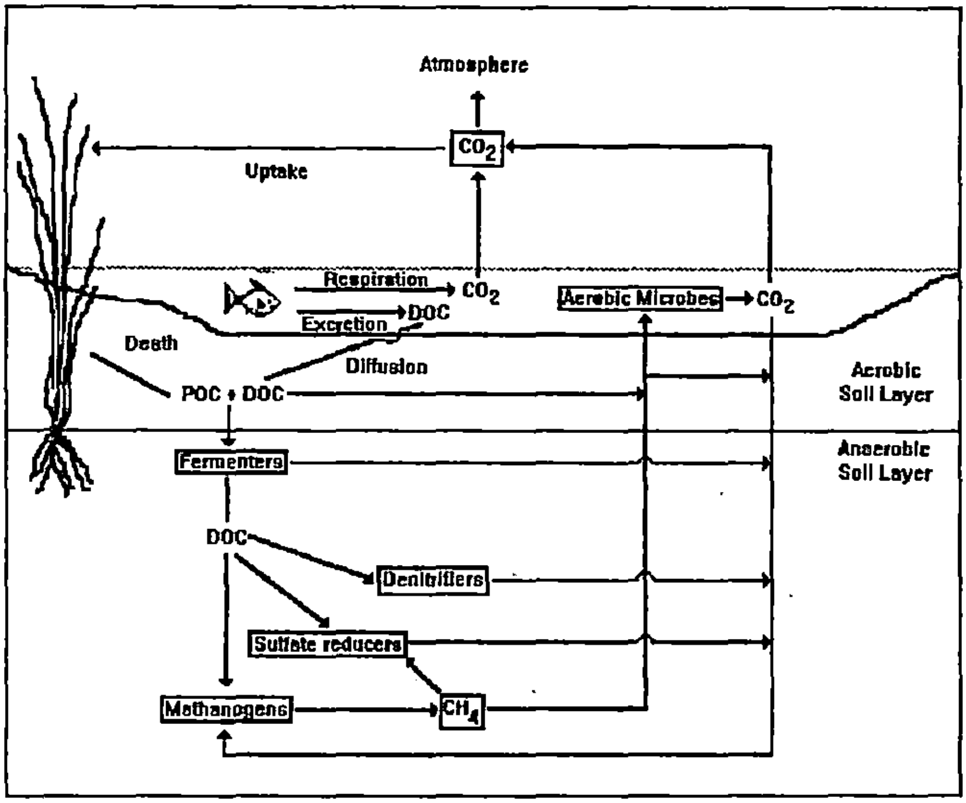

Figure 2.2. Carbon cycle in salt marshes. Adapted from Mitsch and Gosselink (1986).

Odum and de la Cruz (1967) formulated the theory that, as highly productive areas, estuarine salt marshes produce an overabundance of carbon. Excess carbon is exported from the salt marsh system to the adjacent continental shelf where it provides food for planktonic ecosystems. This export process is known as outwelling; the process has been the center of most salt marsh studies. It is my contention that the term "outwelling" be expanded to include all nutrients, as shelf ecosystems require both nitrogen and phosphorus for survival. Therefore, a highly productive marsh producing an excess of any nutrient could "outwell" them, and provide nutrients for adjacent ecosystems.

TABLE 2.3 Carbon flux in estuarine salt marshes of Eastern North America. Values are in g C m^{-2} y^{-1}. Positive values indicate import to the system. Adapted from Nixon (1980).

LOCATION	D.O.C.	P.O.C.	T.O.C	AGE	REFERENCE
Bly Creek, SC	-27.7	52.7		Young	Wolaver & Spurrier (1988)
Flax Pond, NY	-8.4	61	53	Old	Woodwell et al. (1977)
Town Creek, SC	328.0	--		Old	Dame et al. (1986)
Canary Creek, DE	-38	-62	-100		Lotrich et al. (1979)
Gott's Marsh, MD		-7.3			Heinle and Flemer (1976)
Carter Creek, MA	-25	-116	-142		Moore (1974)
Dill Creek, SC		-303			Settlemyer and Gardner (1975)
Barataria Bay, LA	-140	-25	-165		Hap et al. (1977)

Table 2.3 shows carbon flux in salt marshes along the eastern United States. Dissolved organic carbon (D.O.C.) and particulate organic carbon (P.O.C.) are typically exported from these systems, although magnitude and direction of flux is variable. A comparison can be made for carbon flux between geologically old and geologically young systems.

Wolaver and Spurrier (1988) found that Bly Creek, S.C., a geologically young marsh system, imported P.O.C., and exported D.O.C. In contrast, Dame et al. (1986)

found that Town Creek, S.C., a geologically old system, imported D.O.C.. However, studies by Woodwell et al. (1977) indicated that an old salt marsh system in New York imported D.O.C., and exported P.O.C. Contradictions in these two studies may be due to differences in sediment types; Town Creek has predominantly sand sediments, and Flax Pond, MD., has predominantly silt and clay sediments (Woodwell et al. 1977; Reeder et al., in press).

Previous Work

The work of Odum and De La Cruz, published in 1967, initiated a revolution in the way that coastal ecosystems were studied. For years, following their work, salt marsh ecosystems were investigated to determine the magnitude and direction of nutrient flux between salt marshes and the adjacent continental shelf. Several studies found that the magnitude of nutrient flux was small, and the direction highly variable (Moore 1974; Settlemeyer and Gardner 1975; Happ et al. 1977; Woodwell et al. 1977; Heinle and Flemer 1976; Chranowski et al. 1982). However, the question remained: what is variable in marshes that causes them to function differently?

Outwelling studies took a new direction. Concentration on sources and sinks of nutrients prevailed over the determination of the net flux of nutrients. Since oceanic water is typically nutrient poor, enrichment must occur within salt marsh ecosystems or be imported from the forested uplands areas.

Rivers and terrestrial watersheds were first investigated as sources for nutrient imports. Along the gulf coast, where riverine influence was strong, nutrient imports to the marsh systems was high (Happ et al. 1977). However, along the eastern seaboard, riverine influence was negligible, indicative of an internal source for nutrients in salt marsh ecosystems (Happ et al. 1977). Since water flooding salt marshes typically overflowed tidal creek banks, the vegetated marsh became a suspected source for excess nutrients.

Weirs were constructed in a mesohaline marsh in Virginia (Valielai and Teal 1978) to examine nutrient contribution made by the marsh surface. Water washing over the marsh surface during flood tide was typically high in inorganic nutrients; water running off the marsh surface during ebb tide was high in organic nutrients. However, there was no net increase in nutrient mass entering or leaving; this suggested that the marsh surface was acting as a transformer of nutrients rather than of a source of nutrients. Such a conclusion was later reinforced by the work of Whiting and Childers (1989); they found no net flux of nutrients between a vegetated marsh in North Inlet, S.C., and the adjacent tidal creek.

Since weir studies proved to be inconclusive, seepage or groundwater flow was suggested as a source of nutrients. Several investigators turned to seepage and groundwater flow as a source of nutrients when runoff studies proved inconclusive. Whiting and Childers (1989) decided to conduct further investigations. They constructed chambers to "tap into" groundwater flow, and examine this medium as a possible source of nutrients. Pore water was found to contain very high concentrations of all chemical species, and could contribute to the export of nutrients from marsh and tidal creek sediments. Therefore, studies of nutrient flux should include examinaton of advective flow as a possible source of nutrients in estuarine salt marshes.

CHAPTER III

MATERIALS AND METHODS

Site Description

North Inlet, in South Carolina is a bar-built estuarine marsh system located north of Georgetown, South Carolina (Figure 4.1). The estuary drains 32 square kilometers of salt marsh. The hydrology of the North Inlet system is run by a semi-diurnal tide with an amplitude of 1.5 - 2.0 meters, a mean velocity of 1.4 m s^{-1}, and a hydrodynamic residence time of fifteen hours (Gardner and Bohn 1980; Kjerfve et al. 1986). Terrestrial inputs are minimal. It is estimated that 40% of the water entering the estuarine system leaves at each ebb tide. Sea level rise since the last glaciation is apparent in the North Inlet system. The oceanic margins are sinking at a rate of 2.0 cm yr^{-1}; depression causes the marsh to encroach on the forested watershed (Gardner and Bohn 1980). The encroachment forms new marsh areas, as well as new tidal creeks. Such systems are termed transgressive systems.

The North Inlet system consists of *Spartina*-dominated salt marshes interconnected by a series of tidal creeks. The creeks serve as hydrologic, as well as nutrient, conduits, within the marsh and between the marsh and the Atlantic Ocean. As a result, water within North Inlet is in contact with tidal creek sediments for an extended period of time.

Since 1981, North Inlet has been designated by the National Science Foundation as a long term ecological research center (L.T.E.R.). As part of this research project, water samples have been taken for the past ten years at 10:30 a.m. each day. Samples are analyzed for nitrate, ammonia, dissolved organic carbon, and ortho-phosphate. The collected data indicate that the system, as a whole, serves as a source of nutrients for the adjacent continental shelf (Wolaver et al. 1986; Whiting et al. 1987).

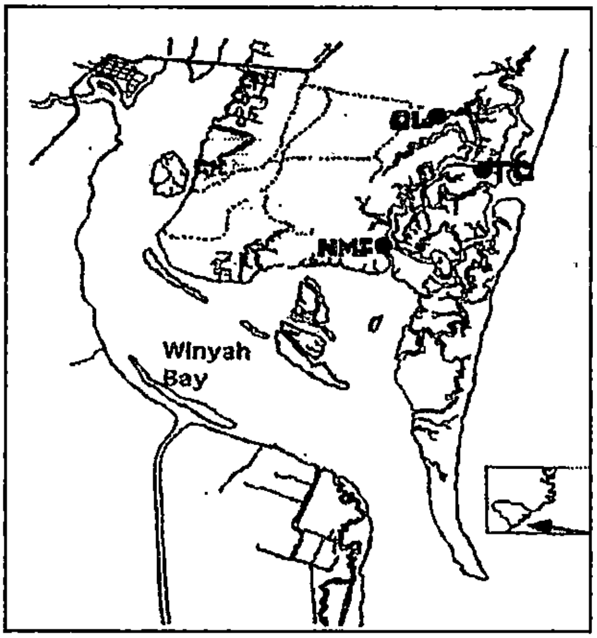

Figure 3.1. Site diagram of North Inlet, South Carolina. OL=Oyster Landing, TC=Town Creek, and NMF=No Man's Friend.

Tidal Creek Sampling Sites

North Inlet consists of three major types of tidal creeks: geologically young, saline; geologically intermediate, saline; and geologically old, brackish (Dame et al. 1980). For purposes of this project, tidal creeks were selected which best represented each of the three creek types.

The northern boundary of North Inlet is characterized by forested watersheds with geologically young, saline tidal creeks. The creek systems are the products of tidal action that has cut into relic beach sediments (Gardner 1980). On the eastern boundary, there are old saline tidal creeks that drain the marsh system into the ocean. The western and southwestern boundaries consist of old, riverine-built tidal creeks that have been inundated with saline waters. As a result, tidal creeks in western and southwestern areas have riverine-dominated sediments, but are overlain with high salinity waters (Reeder et al., in press).

Oyster Landing (OL) is a geologically young tidal creek with strong oceanic influences. The creek was formed following sea level rise; tidal forces cut into relic beach sediments on the forested boundary of North Inlet (Figure 4.1). Scouring and sediment export is high in this area; sediments are primarily sand. The study site at Oyster Landing is 24 meters wide with a maximum depth during flood tide of 95 centimeters, and an average depth of 63.3 cm.

Town Creek (TC) is a geologically old, saline marsh located at the mouth of North Inlet. More than 70% of the water that leaves the marsh-estuarine system passes through this creek (Dame et al. 1986). The study site is located 100 meters east of the junction of Debbidue Creek and Jones Creek (Figure 4.1). A representative transect was chosen 100 meters wide with a average maximum depth of 73 centimeters at high tide, and a average depth of 45 centimeters.

No Man's Friend (NMF) is a geologically old, brackish tidal creek located at the northern edge of the Mud Bay section of Winyah Bay. The study site is 100 meters wide, with an average maximum depth of 200 centimeters and a mean depth of 90 centimeters. This site is located in a transition zone between oceanic and fresh water influences in the North Inlet System, and, consequently, has high sedimentation rates.

Sediment Collection and Analysis

At each of the three sites (OL, TC, and NMF), a measuring tape was used to run a transect across each tidal creek; the transect was perpendicular to the creek bank. Sediment samples were collected by hand, or by employing an Eckman Dredge. Samples were placed in 2.2 liter plastic zip-lock bags, labeled, and placed on ice for transport. At OL, samples were taken at 2 meter intervals; at TC and NMF, samples were taken at 10 meter intervals. The difference in numbers of samples collected in the sites was due to the small transect distance of Oyster Landing (24 meters). A lead line, or a meter stick, was used to measure depth at each interval. Samples collected were transported, on ice, to Morehead State University for analysis.

Nutrient Analyses

Two hundred gram wet, sub-samples were placed in 250 ml zip-lock bags. Prepared samples were sent to the University of Kentucky Soils Laboratory for micro- and macro-nutrient analysis. Nutrient analyses were performed according to standard methods; analyses were made for carbonate (CO_3), Malich extractable phosphorus (MP), Malich extractable potassium (MK), calcium (Ca), magnesium (Mg), and total Kjeldahl nitrogen (TKN). The remainder of the sediments collected were refrigerated and stored for subsequent analyses performed at Morehead State University.

Particle Size Distribution

Fifty gram soil samples collected in all three sites (OL, TC, NMF) were oven dried at 110°C for 24 hours, and analyzed for particle size distribution. The Bouyocos Hydrometer Method (Brady 1990) was used to determine particle size. Samples were prepared by grinding the soil in a mortar and pestle to obtain uniform size; samples were weighed to the nearest .001 gram. After the samples were weighed, each was placed in a 500 ml. beaker containing 100.0 ml of distilled water and stirred mechanically. Five ml of 1.00 N sodium hexametaphosphate was added to prevent small-particle aggregation. The slurry was mixed on a mechanical stirring plate. After 7-8 minutes, the slurry was poured into an 1100 ml. settling cylinder. The cylinder was filled to the 1050 ml mark, shaken vigorously, and placed in an upright position. A hydrometer was inserted in the cylinder, and time and temperature were recorded; readings were made after 40 seconds. A second reading was taken after two hours, and temperature was recorded. Hydrometer readings showed grams of soil material remaining in solution. Readings were corrected for temperature by subtracting .25 grams for each 1°C below 18°C, or adding .25 grams for each 1°C above 18°C. Calculations for each particle size were made.

1. Grams Sand = Total sample weight - corrected 40 second reading
2. Grams Silt = Corrected 2-hour hydrometer reading
3. Percent Weights = $\frac{\text{sediment fraction weight}}{\text{total sample weight}} \times 100$

All size fractions were tabulated and converted to kg m^{-3} of each sediment fraction. Data are recorded in Appendix A.

Sediment Characteristics

To further characterize North Inlet sediments, analyses were made to determine bulk density, percent organic matter, and percent carbonate. Duplicate wet sub-samples were placed in 8.00 ml. crucibles, filled level with the top of the crucible, and oven dried at 110°C for 24 hours. The samples were then analyzed for percent organic matter; values were determined by loss on ignition at 550°C . After cooling and weighing, the samples were combusted at 1200°C for 2 hours to determine carbonate composition (Dean 1974). All samples, at each step in the analysis, were brought to constant weight; constant weight was determined as the sample weight ± .002 grams. Calculations for each fraction were as follows.

1. Bulk Density $= \dfrac{\text{Dry weight } (110^{o}C)}{\text{Volume of Crucible}}$

2. Percent Organic Matter $= \dfrac{\text{Weight on Ignition - Dry Weight}}{\text{Sample Weight}} \times 100$

3. Percent Carbonate $= \dfrac{\text{Weight on Combustion - Weight on Ignition}}{\text{Sample Weight}} \times 100$

Adsorption Isotherms

To better understand phosphorus absorption-desorption kinetics in North Inlet sediments, absorption isotherms were determined for each sediment sample. Absorption isotherms are useful, because they reveal the concentration of a particular nutrient that a sediment sample can absorb out of a particular solution. Isotherms were determined by incubating a sediment sample in various concentrations of a nutrient; the supernatant was then analyzed for the concentration of the nutrient. The amount of the nutrient absorbed was calculated as the difference between initial and final concentrations of the nutrient in the supernatant.

Duplicate 1.000 gram dry sediment samples were incubated in phosphorus solutions ranging from 0 to 500 $\mu g\ PO_4^{-3}$ -P L^{-1}. Isotherm solutions were made by diluting 50 $\mu g\ PO_4^{-3}$ -P L^{-1} standard solution with filtered Atlantic seawater to a total volume of 1.00 liter. Isotherms were determined for both full-strength seawater (34 ppt.) and brackish water (5 ppt.). The initial concentration of dilutant water was 15.96 $\mu g\ PO_4^{-3}$ -P L^{-1}.

Sediment samples were placed in 50.0 ml Nalgene centrifuge tubes, and flooded with 33.0 milliliters of each isotherm solution. This slurry was then placed in an over-under inversion box that inverted samples at a rate of 20 inversions/minute; the samples were inverted for 24 hours. The specific amount of time was chosen to allow for ample contact time between the isotherm solutions and the sediments.

Following incubation, samples were centrifuged at 10,000 rpms for 30 minutes, and the supernatant was decanted and collected. The supernatant was filtered through 0.45 micron glass fiber filters, using a vacum filtering apparatus. The filtrate was collected, and analyzed for ortho-phosphate using a Technicon II Autoanalyzer (Absorbic Acid Reduction, Lobrig (1973)). All runs were performed in duplicate, and total absorptive capacity was calculated for each sediment sample. Raw data collected are presented in Appendix B.

Chamber Design

An *in situ* measuring technique was developed that integrated all factors acting concurrently on the sediment-water system. Utilizing a chamber design modified from the design of Chambers (1991), nutrient flux was quantified in the field with some degree of accuracy. Several modifications were made to Chambers' original design. To eliminate advective flow and allow for greater tidal range, chambers were three meters in length, to facilitate placing them deep into the sediments. The chambers were sufficiently large to preclude the need for sealing; thus, preventing problems incurred by producing anaerobic conditions.

Chambers were constructed using 6 inch diameter PVC water delivery pipe. A hole was drilled in the pipe, one meter from the bottom, to accommodate a 3/4-inch nalgene nipple. Holes were drilled at 20 cm intervals along the remainder of the pipe to accommodate 1/2-inch serum stoppers. The serum stoppers allowed for water samples to be extracted from the chamber, using a syringe fitted with a 20 gauge needle. In addition, a hole at 10 cm above the 3/4-inch nipple was drilled to permit the examination of the sediment-water interface. See Figure 3.2; a diagram of the chamber design.

The sediment data collected from the transects were analyzed using the Cluster procedure of SAS (SAS Institute, (1988)), to determine placement of the chambers. Using maxcluster = 3, the analysis divided each tidal creek into three zones, corresponding to *Spartina* marsh (M), creek bank (B), and middle of the creek (C).

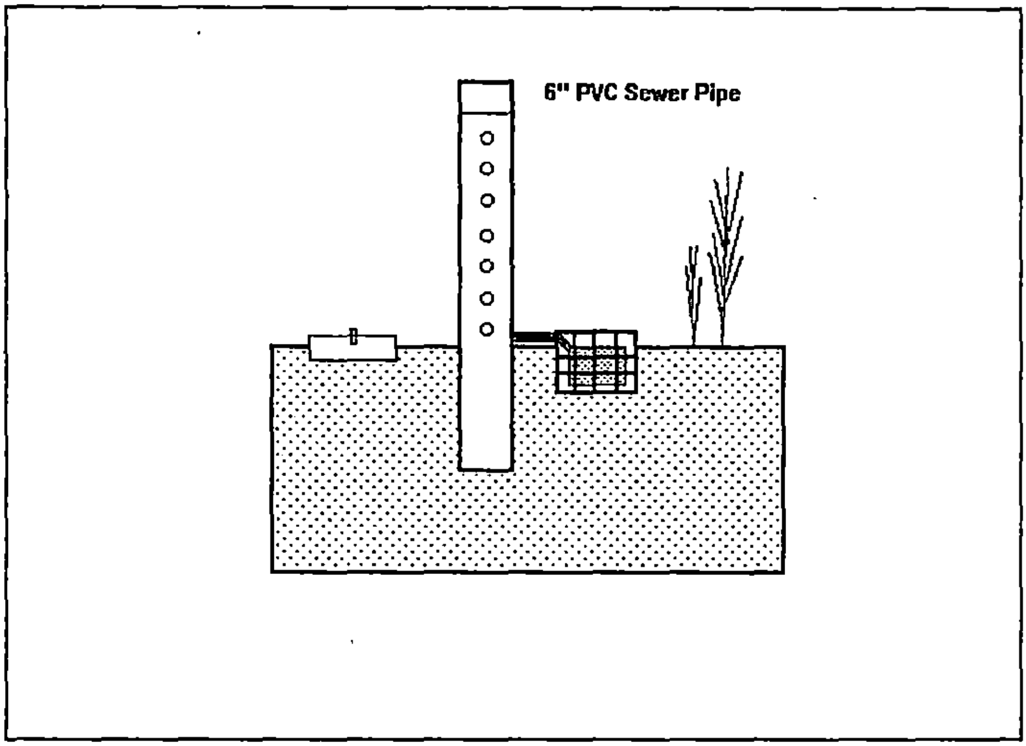

Figure 3.2. Design of nutrient flux flow chambers.

In the geologically young, saline creek (Oyster Landing); the marsh zone (M) corresponded to transect distances 0, 2, and 6; the bank zone (B) corresponded to D=14, 16, 18, 20, and 22; and the creek zone (C) corresponded to distances 4, 8, 10, and 12. The r^2 for these clusters = 0.7885. Clusters in the geologically old, saline tidal creek (Town Creek) corresponded to D=0 for M; D=10, 20, and 70 for B; and D=30, 40, 50, 60, 80, 90, 100 for C. The r^2 for these clusters was 0.8694. In the geologically old, brackish creek (No Man's Friend), M clusters included D=10, 30; B cluster included distances D=20, 40, 80; and C cluster included D=50 and 90. The r^2 for No Man's Friend clusters was 0.9518.

Using the middle of each of these zones, duplicate chambers were placed in each tidal creek (OL, TC, NMF) in each of the three zones (M, B, C). Each chamber was placed one meter into the sediments to eliminate advective flow. The chambers were attached to 20.0 liter compressible reservoirs filled with Atlantic seawater. Reservoir bags were secured in plastic milk crates, and attached to fittings on each chamber using 5/8-ID Nalgene tubing. Rubber serum stoppers were inserted into the chambers to facilitate sampling. Samples were collected by using acid-washed 20 cc plastic syringes fitted with 20 gauge needles.

In addition to the placement of nutrient flux chambers in each site, advective flow was measured at each site, using a modified chamber design of Whiting and Childers (1990). Fifty liter plastic garbage cans were cut to a height of 10 cm., then drilled at the top to facilitate three 1/2-inch ports. The center port was fitted with a 3/4 inch snap-on fitting; the male fitting was attached to a 2.2 liter plastic bag. The acid-washed chambers were positioned adjacent to each pair of nutrient flux chambers in each site (Figure 3.3). Chambers were opened, and allowed to equilibrate at least 12 hours before being closed for sampling.

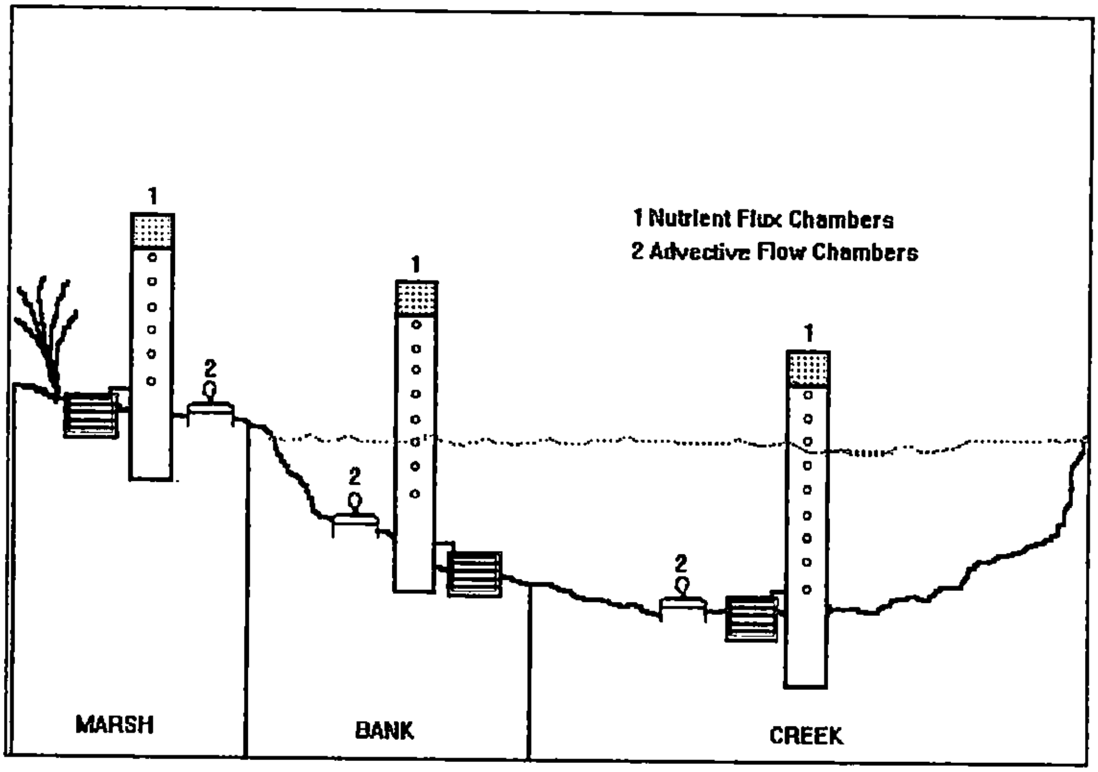

Figure 3.3. Placement of benthic and advective flow chambers.

Sampling Methods

The three sites, Oyster Landing (OL), Town Creek (TC), and No Man's Friend (NMF), were sampled once in June 1991, and three times in July 1992. Sampling techniques involved the filling of one bag for each chamber, with Atlantic seawater, and attaching a bag to each chamber. Each port was sampled during the tidal range. Evacuated 1.00 liter bags were attached to the advective flow chambers at time zero. The chambers were sampled from high tide to low tide (ebb) during the summer of 1991, and from low tide to high tide (flood) during the summer of 1992.

Water samples were taken from each reservoir, before the reservoirs were attached to the chambers, to determine initial nutrient concentrations. Following complete installation, the chambers were sampled at two-hour intervals during each tidal event. At the beginning of each sampling interval, bags from advective flow chambers were removed, the volume was recorded, and water samples were placed in acid-washed vials. Samples were taken from each submerged port, using a 20cc syringe. Samples were placed in numbered, acid-washed scintillation vials. All samples were then placed on ice for transport to the University of South Carolina chemistry laboratory for nutrient analysis.

Statistical Methods

All statistical methods were conducted using SAS version 6.03. The CLUSTER (with MAXCLUSTER=3) procedure was used to place hierarchical clusters of the sediment data into definable groups. The analysis of variance within the three sites (OL, TC, and NMF) was determined, using the ANOVA procedure; this procedure was used because the experimental design was balanced. SCHEFFE, SNK, and t tests were conducted on each variable, to determine if the means of each dependent variable varied significantly, each from the other. Appendix D contains the SAS programs used for the statistical analysis of nutrient flux.

Mathematical Models and Terms

A model was constructed for the sediment values for each of the three sites. Models were constructed to relate sediment values to distance from shore (D), and depth (Z). Table 3.1 lists terms used in the models.

Table 3.1. Terms used in mathematical models and results.

TERM	PARAMETER	UNITS
L	LOCATION	OL, TC, NMF Sites
D	Distance from shore	meters (M)
Z	Depth	centimeters (cm)
S	Location in site	marsh, bank, creek
TD	Direction of tidal flow	flood, ebb
P	Ortho-phosphate	μg-at m^{-2} $tide^{-1}$
NO	Nitrate	μg-at m^{-2} $tide^{-1}$
NH	Ammonia	μg-at m^{-2} $tide^{-1}$
C	Carbon	μg-at m^{-2} $tide^{-1}$

Net nutrient flux in each site was determined using two basic formulas employing raw data presented in Appendices C and D.. The formula for flood nutrient flux is as follows.

$$\sum_{t_i - t_f} \alpha_3\beta_3 - \alpha_2\beta_2 - \alpha_1\beta_1 \quad \text{(Eq. 3.1)}$$

where

t_i = initial time

t_f = final time

α_1 = Concentration at Time 1

α_2 = Concentration at time 2

α_3 = Concentration at time 3

β_1 = Volume at time 1

β_2= Volume at time 2

β_3 = Volume at time 3

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$$\sum [illegible]$$

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The following formula was used to calculate total ebb tide flux.

$$\sum_{t_i - t_f} (\alpha_1\beta_1) + ((\alpha_2\beta_2) - (\alpha_1\beta_1 - \alpha_2\beta_2)) + ((\alpha_3\beta_3) - (\alpha_2\beta_2 - \alpha_3\beta_3)) \quad \text{(Eq. 3.2)}$$

where

t_i = initial time

t_f = final time

α_1 = Concentration at time 1

α_2 = Concentration at time 2

α_3 = Concentration at time 3

β_1 = Volume at time 1

β_2 = Volume at time 2

β_3 = Volume at time 3

The following mathematical models were constructed to statistically analyze nutrient flux in each site. Additionally, hypothesis to be tested follow each mathematical model.

A. Mathematical Models for Nutrient Flux In North Inlet.

1. Oyster Landing

$P_{ij}, NO_{ij}, NH_{ij}, C_{ij} = \mu + S_i + DR_j + SDR_{ij} + E_{k(ij)}$

i = Nutrient value at each level of S (Marsh, Bank, Creek)

j = Nutrient value at each level of DR (Ebb, Flood)

k = Observation in each treatment (1,2)

Ho_1: $S_i = 0$ for all i

Ho_2: $DR_j = 0$ for all j

Ho_3: $SDR_{ij} = 0$ for all i and j

2. No Man's Friend

P_{ij} , NO_{ij} ,NH_{ij} , $C_{ij} = \mu + S_i + DR_j + SDR_{ij} + E_{k(ij)}$

i = Nutrient value at each level of S (Marsh, Bank, Creek)

k = Observation in each treatment (1,2)

j = Nutrient value at each level of DR (Ebb, Flood)

Ho_1: $S_i = 0$ for all i

Ho_2: $DR_j = 0$ for all j

Ho_3: $SDR_{ij} = 0$ for all i and j

3. Town Creek

P_{ij} , NO_{ij} , NH_{ij} , $C_{ij} = \mu + S_i + DR_j + SDR_{ij} + E_{k(ij)}$

i = Nutrient value at each level of S (Marsh, Bank, Creek)

k = Observation in each treatment (1,2)

j = Nutrient value at each level of DR (Ebb, Flood)

Ho_1: $S_i = 0$ for all i

Ho_2: $DR_j = 0$ for all j

Ho_3: $SDR_{ij} = 0$ for all i and j

4. Between all three sites

$$P_{hij} , NO_{hij} , NH_{hij} , C_{hij} = \mu + L_h + S_i + DR_j + LSDR_{hij} + LS_{hi} + LDR_{hj} + SDR_{ij} + E_{k(ijk)}$$

h = Nutrient value at each location (OL, TC, NMF)

i = Nutrient value at each region (Marsh, Bank, Creek)

j = Nutrient value with each direction (Ebb, Flood)

k = Observation in each treatment (1,2)

$Ho_1: L_h = 0$ for all h

$Ho_2: S_i = 0$ for all i

$Ho_3: DR_j = 0$ for all j

$Ho_4: LSDR_{hij} = 0$ for all h, i, and j

$Ho_5: LS_{hi} = 0$ for all h and i

$Ho_6: LDR_{hj} = 0$ for all h and j

$Ho_7: SDR_{ij} = 0$ for i and j

B. Mathematical Models for Total Net Nutrient Flux in North Inlet.

1. Oyster Landing

$P_i, NO_i, NH_i, C_i = \mu + S_i + E_{k(i)}$

i = Nutrient value at each level of S (Marsh, Bank, Creek)

k = Observation in each treatment (1,2)

Ho: $S_i = 0$ for all i

2. No Man's Friend

$P_i, NO_i, NH_i, C_i = \mu + S_i + E_{k(i)}$

i = Nutrient value at each level of S (Marsh, Bank, Creek)

k = Observation in each treatment (1,2)

Ho: $S_i = 0$ for all i

3. Town Creek

$P_i, NO_i, NH_i, C_i = \mu + S_i + E_{k(i)}$

i = Nutrient value at each level of S (Marsh, Bank, Creek)

k = Observation in each treatment (1,2)

Ho: $S_i = 0$ for all i

4. Between all three sites

P_{hi}, NO_{hi}, NH_{hi}, $C_{hi} = \mu + L_h + S_i + LS_{hi} + E_{k(hi)}$

h = Nutrient value at each location (OL, TC, NMF)

i = Nutrient value at each region (Marsh, Bank, Creek)

k = Observation in each treatment (1,2)

Ho_1: $L_h = 0$ for all h

Ho_2: $S_i = 0$ for all i

Ho_3: $LS_{hi} = 0$ for all h and i

Data collected from the benthic chambers during 1991 and 1992 were tabulated in a manner sufficient to determine net movement of nutrients over a tidal cycle. Appendix C. lists raw data for each nutrient, and net flux for those nutrients. Nutrient flux was analyzed using the ANOVA procedure of SAS. Confidence level for all decisions of significance was at $\alpha = .10$, corresponding to a 90% confidence level. Student's t-test was used for pairwise comparisons of means; Stewart-Newman-Keuls test and Scheffe's tests were used to compare all means. The confidence level used in all analyses was 90% (corresponding to an $\alpha = .10$).

CHAPTER IV

RESULTS

Nutrient Flux from Benthic Chambers

Prelimenary Analysis

Nutrient data was analyzed statistically to determine the effect of tidal height on nutrient flux. Tidal height had a variable effect upon the observed nutrient values; however, the mean nutrient concentration at different tidal heights was not significantly different (n=360, PR>F > .01). These findings were supported by Scheffes, SNK, and t tests for means. Since height did not show an affect on nutrient flux, data collected from all ports could be combined to give a total net flux for each chamber.

Oyster Landing

Nutrient flux was strongly correlated with direction of tidal flow (TD) in Oyster Landing (n=12, PR>F= 0.003). During flood tide, phosphorus, nitrate, nitrite and carbon were all exported from the sediments in this site. Export during flood tide was significantly different than export during ebb tide (Figures 4.1 and 4.2). Phosphorus was exported during flood tide, with a mean export of 32.63 μg-at m^{-2} $tide^{-1}$. Phosphorus was also exported from the sediments during ebb tide, with a mean export of 21.23 μg-at m^{-2} $tide^{-1}$. Utilizing t, SNK, and Scheffes test for means, flood and ebb flux of phosphorus was found to be significantly different.

Nitrate was typically exported from the sediments during flood tide (mean = 4.66 μg-at m^{-2} $tide^{-1}$), and imported to the sediments on ebb tide (mean 2.90 μg-at m^{-2}

Nitrate was typically exported from the sediments during flood tide (mean = 4.66 µg-at m^{-2} tide $^{-1}$), and imported to the sediments on ebb tide (mean 2.90 µg-at m^{-2} tide^{-1}). These means were found to be significantly different (n=12, PR>F=0.003). Ammonia was also exported form the sediments during flood tide (133.00 µg-at m^{-2} tide^{-1}), and imported during ebb tide (129.9 µg-at m^{-2} tide^{-1}). However, the means were not significantly different. Carbon in Oyster Landing was exported during flood tide (61.26 µg-at m^{-2} tide-1), and imported during ebb tide (40.33 µg-at m^{-2} tide^{-1}). Utilizing T, SNK, and Sheffes test for means, these means were found to be significantly different.

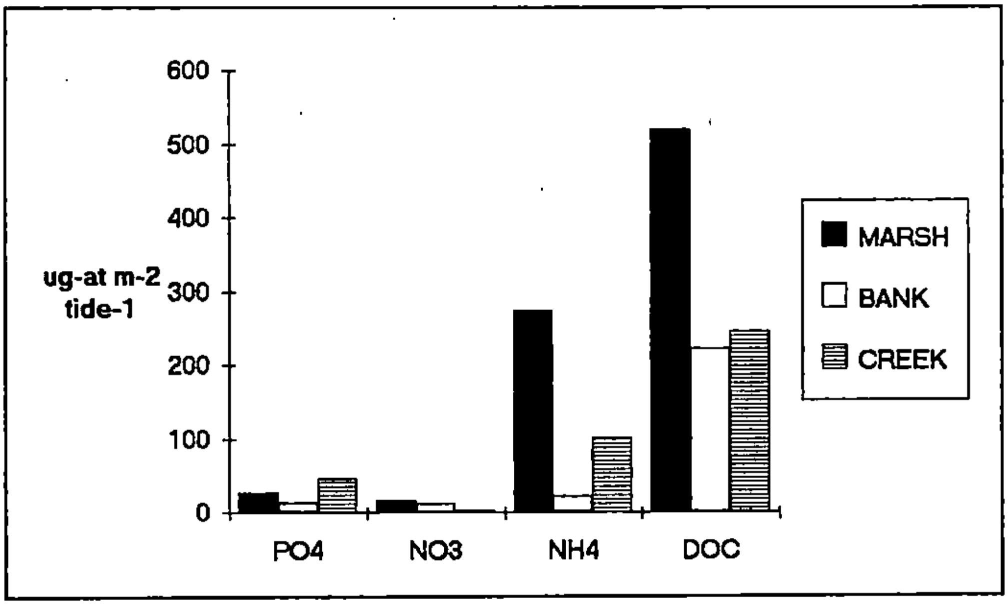

Figure 4.1. Nutrient flux during flood tide in Oyster Landing. Positive values indicate export from the sediments.

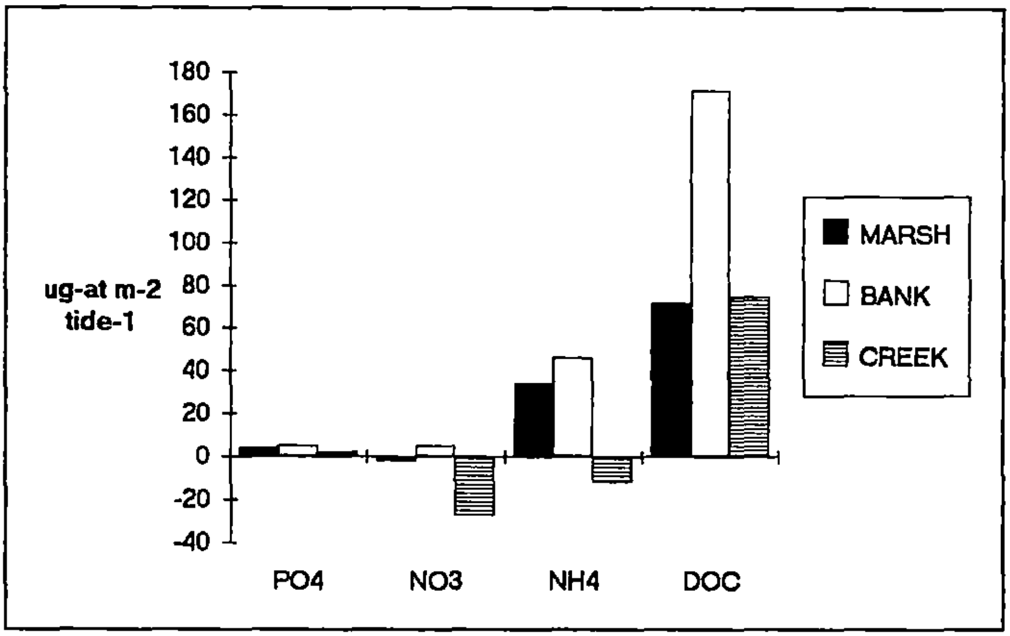

Figure 4.2. Net flux of nutrients during ebb tide in Oyster Landing. Positive values indicate export from the sediments

Nutrient flux in Oyster Landing was not found to be related to tidal creek zone (Marsh, Bank, and Creek), with the exception of carbon; carbon flux was slightly correlated with zone (PR>F = .120). Figure 4.3 shows overall nutrient flux in Oyster Landing.

Phosphorus flux varied from a net import of 17.21 μg-at m^{-2} $tide^{-1}$ in the creek zone to a net export of 7.33 μg-at m^{-2} $tide^{-1}$ in the marsh zone, with a mean export of 5.698 μg-at m^{-2} $tide^{-1}$. Nitrate flux ranged from a net export of 1.52 μg-at m^{-2} $tide^{-1}$ in the creek zone to a net export of 0.19 μg-at m^{-2} $tide^{-1}$ in the marsh zone, with a mean export of 0.88 μg-at m^{-2} $tide^{-1}$. Ammonia flux ranged from a net export of 89.96 μg-at m^{-2} $tide^{-1}$ in the creek zone to a net import of 77.44 μg-at m^{-2} $tide^{-1}$ in the marsh zone, with a mean export of 1.52 μg-at m^{-2} $tide^{-1}$. Carbon flux ranged from a net export of 52.13 μg-at m^{-2} $tide^{-1}$ in the bank zone to a net import of 23.68 μg-at

m^{-2} $tide^{-1}$ within the marsh zone; mean flux was 10.47 μg-at m^{-2} $tide^{-1}$ in the import direction. None of the nutrient fluxes between these three tidal creek zones was significantly different (n=12, PR>F > 0.10).

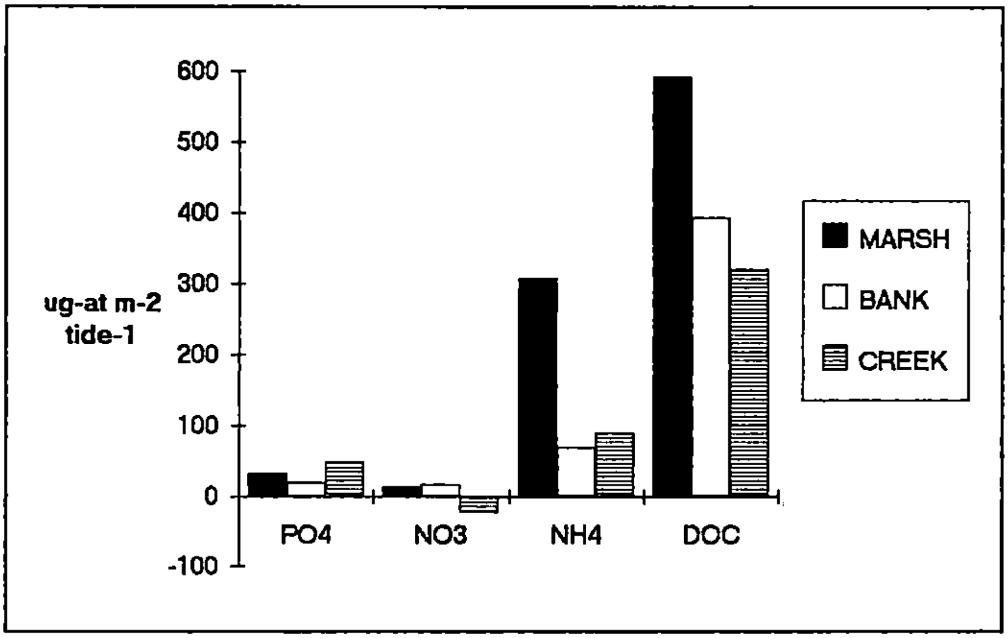

Figure 4.3. Overall nutrient flux in Oyster Landing. Positive values indicate export from the sediments.

<u>Town Creek</u>

Nutrient flux in Town Creek was strongly correlated with tidal flow direction for phosphorus (PR>F=.02) and carbon (PR>F=.0046), but not for nitrate (PR>F=.0497) and ammonia (PR>F=.635). However, PR>F for nitrate was in the decision range (between 0.10 and 0.01), and must be discerned using Scheffe, SNK, and t tests for means. Town Creek functioned as a slight source for all nutrients during flood tide, and a source for all nutrients, except ammonia, during ebb tide (Figure 4.4 and Figure 4.5).

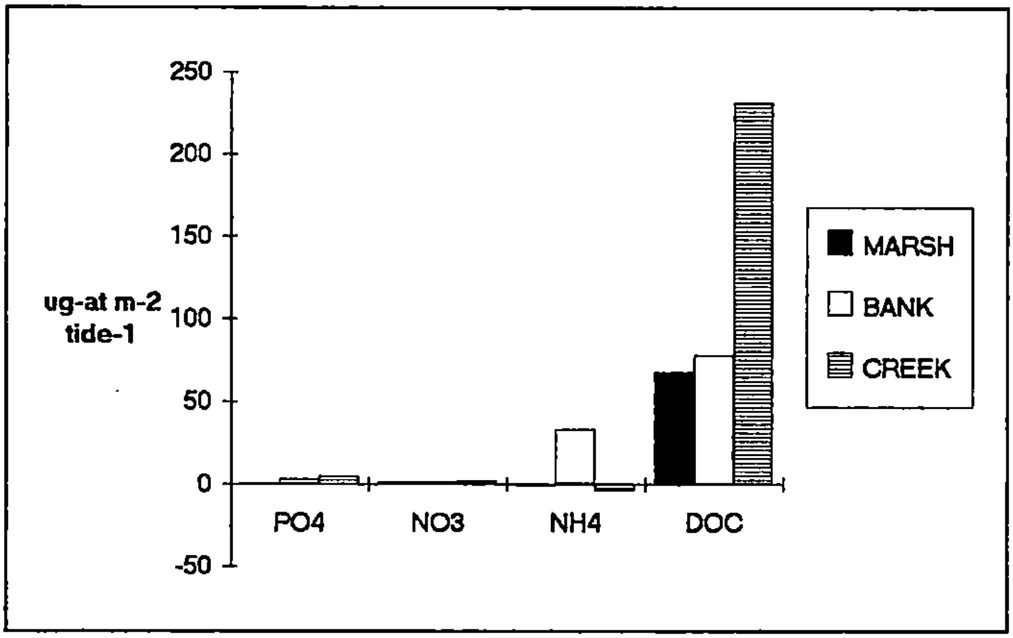

Figure 4.4. Net flux of nutrients in Town Creek during flood tide. Positive values indicate export from the sediments.

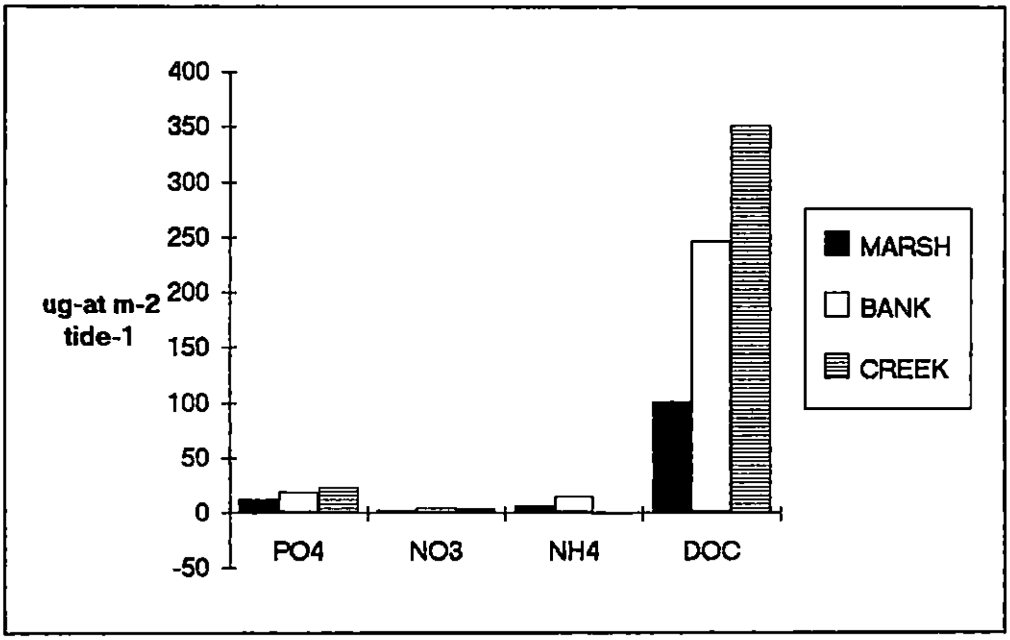

Figure 4.5. Net flux of nutrients during ebb tide in Town Creek. Positive values indicate export from the sediments.

Nutrient flux in Town Creek was not strongly correlated with the three zone in this tidal creek (PR>F>.01), with the exception of carbon (PR>F=.0046). Figure 4.6 shows that Town Creek serves as a source for nutrients in all three zone, with the exception of a small import of ammonia in the creek zone.

Phosphorus flux ranged from a high export of 6.63 μg-at m^{-2} $tide^{-1}$ in the creek zone to a low of 2.84 μg-at m^{-2} $tide^{-1}$ in the marsh zone. Mean flux of phosphorus in Town Creek was 4.99 μg-at m^{-2} $tide^{-1}$. Nitrate flux ranged from a high export of 1.23 μg-at m^{-2} $tide^{-1}$ in the bank zone to a low export of 0.98 μg-at m^{-2} $tide^{-1}$ in the marsh zone. Mean flux for nitrate was 1.099μg-at m^{-2} $tide^{-1}$.

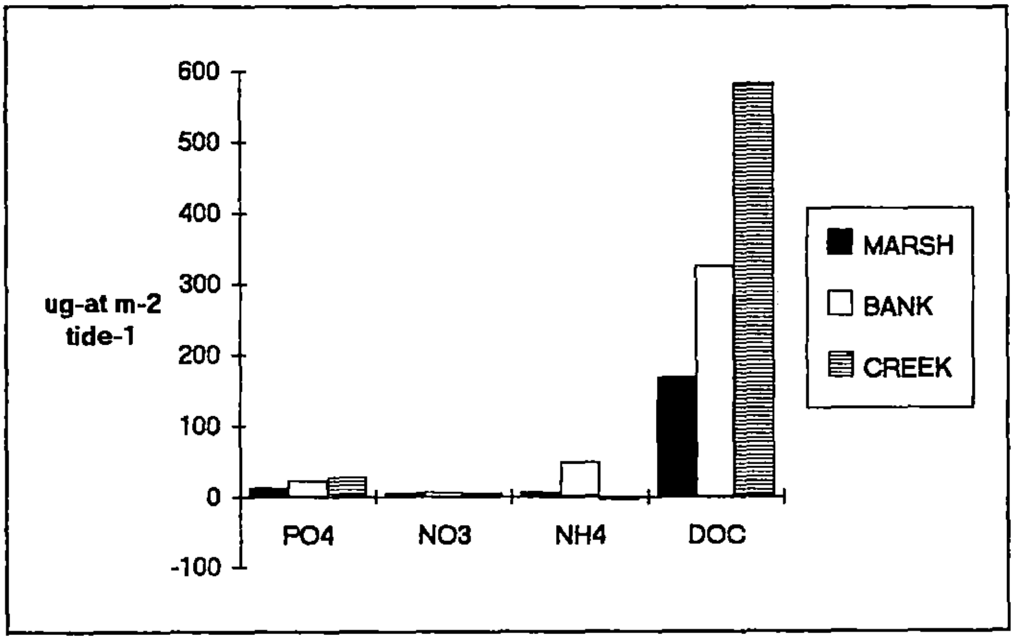

Figure 4.6. Overall net flux in Town Creek. Positive values indicate export from the sediments.

Ammonia was exported from the marsh and bank zones in Town Creek, but imported by the creek zone. Flux of this nutrient ranged form an export of 12.11 μg-at m^{-2} $tide^{-1}$ to a net import of NH_4 of 1.38 μg-at m^{-2} $tide^{-1}$ in the creek zone. Mean flux of this nutrient was 4.01 μg-at m^{-2} $tide^{-1}$. Net nutrient flux in the three zone was not significantly different, with a PR>F value of .3089.

Carbon was exported from all three zones in Town Creek. Net export of carbon ranged from a high of 145.78 μg-at m^{-2} $tide^{-1}$ to a low export of 42.15 μg-at m^{-2} $tide^{-1}$. Utilizing t, SNK, and Scheffes test for means, carbon flux was found to be significantly different in all three zones.

No Man's Friend

Flux of nutrients was highly variable in No Man's Friend. Figure 4.7 shows that all nutrients were exported during flood tide, with the exception of nitrate in the marsh zone and phosphate in the bank zone.

Figure 4.8 shows that No Man's Friend imports all nutrients during ebb tide, with the exception of a small export of ortho-phosphate in the bank zone and a small export of nitrate in the marsh zone. The creek zone imported the largest amount of nutrients during ebb tide in No Man's Friend. Nitrate and dissolved organic carbon import is strongly correlated with the direction of tidal flow (TD) in No Man's Friend (PR>F = .0003 for NO_3 and .0078 for DOC). Probability values for phosphorus and ammonia were in the decision range (0.10>PR>0.01), and were determined using t, SNK, and Scheffes tests for means.

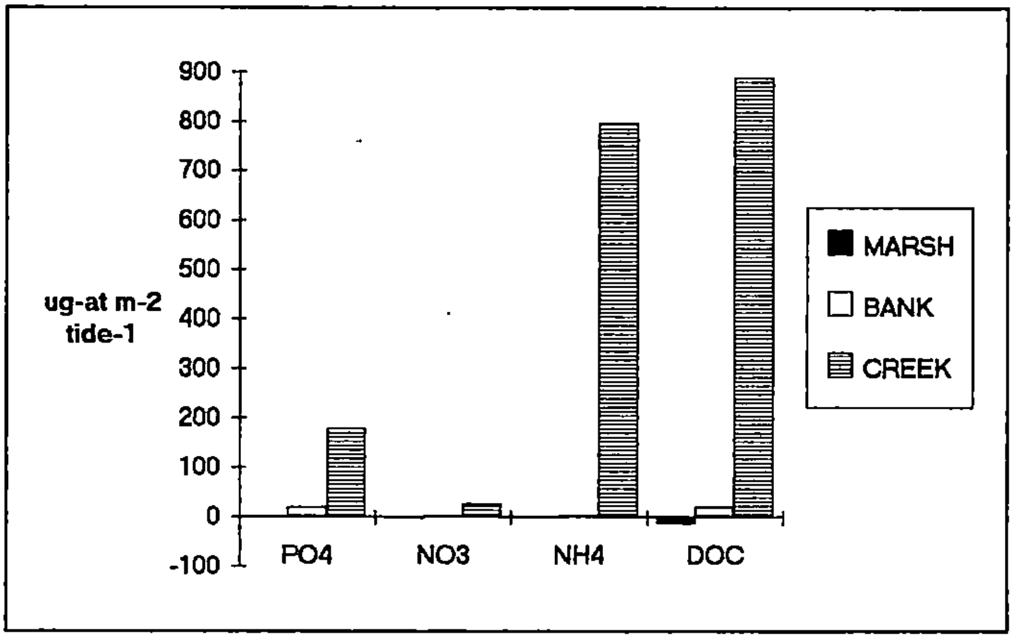

Figure 4.7. Net flux of nutrients during flood tide in No Man's Friend. Positive values indicate export from the system.

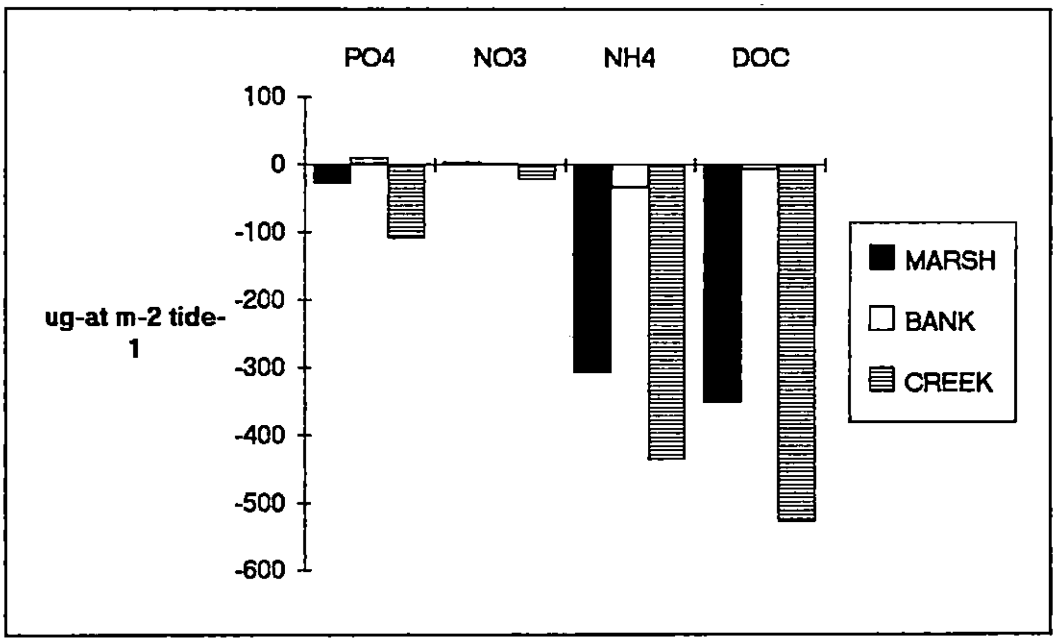

Figure 4.8. Net flux of nutrients during ebb tide in No Man's Friend. Positive values indicate export from the sediments.

Flux of ortho-phosphate in No Man's Friend ranged from an export of 32.63 μg-at m^{-2} $tide^{-1}$ during flood tide to an import of 21.23 μg-at m^{-2} $tide^{-1}$ during ebb tide. Mean flux of PO_4 was 5.70 μg-at m^{-2} $tide^{-1}$. Flux of nitrate ranged from an export of 4.67 μg-at m^{-2} $tide^{-1}$ during flood tide to an import of 2.90 μg-at m^{-2} $tide^{-1}$ during ebb tide. Mean flux of nitrate was 0.884 μg-at m^{-2} $tide^{-1}$. Scheffes, SNK, and t tests indicated that mean flux of nitrate and ortho-phosphate was significantly different during flood tide and ebb tide.

Ammonia flux was large in No Man's Friend, ranging from a net export of 133.0 μg-at m^{-2} $tide^{-1}$ during flood tide to an import of 129.9 μg-at m^{-2} $tide^{-1}$ during ebb tide. Mean flux of ammonia was 1.53 μg-at m^{-2} $tide^{-1}$. Carbon was exported during flood tide and imported during ebb tide in No Man's Friend. Carbon flux ranged from an export of 61.26 μg-at m^{-2} $tide^{-1}$ during flood tide to an import of 40.33 μg-at m^{-2} $tide^{-1}$ during ebb tide. The mean export of DOC was 10.47 μg-at m^{-2} $tide^{-1}$. Scheffes, SNK, and t tests supported the conclusion that the mean flux of ammonia and carbon between flood tide and ebb tide was not significantly different.

Figure 4.9 shows that, overall, the creek zone imported nutrients and the marsh zone exported nutrients in No Man's Friend. Direction of nutrient flux was variable in the marsh zone; ortho-phosphate, ammonia, and DOC were all imported. Nitrate, however, was exported from sediments in the marsh zone.

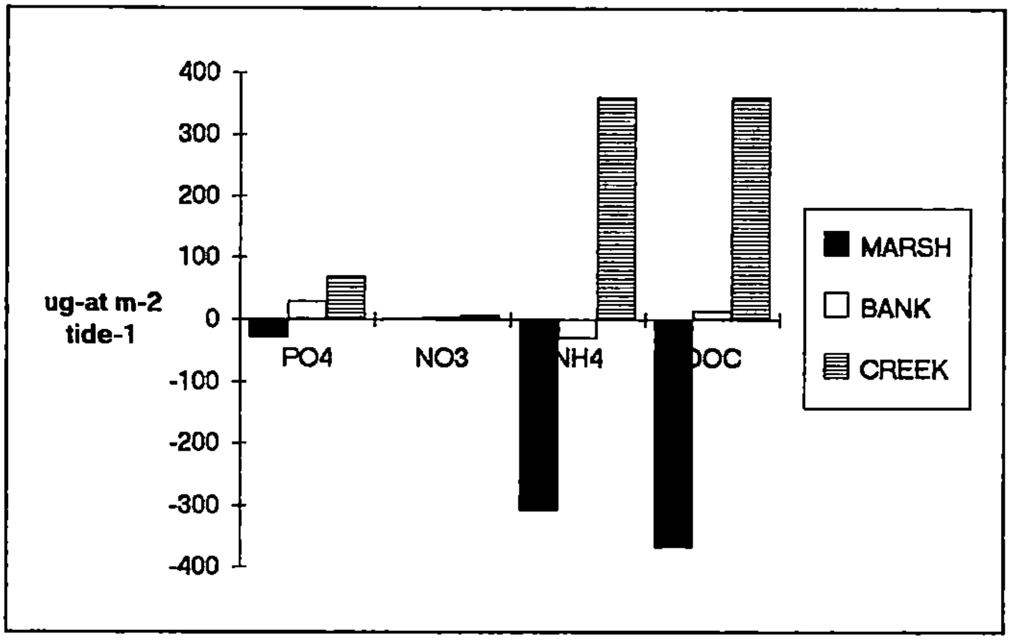

Figure 4.9. Overall net flux of nutrients in No Man's Friend. Positive values indicate export from the sediments.

Overall, ortho-phosphate, nitrate, and ammonia flux were not correlated with a particular zone in No Man's Friend. Carbon was slightly correlated with the three zones (S), indicated by a PR>F value of .1292. Flux of ortho-phosphate in these three zones ranged from an export of 17.21 μg-at m^{-2} $tide^{-1}$ in the creek zone to an import of 7.33 μg-at m^{-2} $tide^{-1}$ in the marsh zone. Overall, ortho-phosphate was exported, with a mean flux of 5.69 μg-at m^{-2} $tide^{-1}$. Nitrate was exported in all three zones in No Man's Friend. Flux of nitrate ranged from an export of 1.521 μg-at m^{-2} $tide^{-1}$ in the creek zone to an export of 0.187 μg-at m^{-2} $tide^{-1}$ in the marsh zone. Mean nitrate export in No Man's Friend was 0.885 μg-at m^{-2} $tide^{-1}$. Ammonia was typically imported in the marsh and bank zones, and exported in the creek zone. Flux of ammonia ranged from an export of 89.96 μg-at m^{-2} $tide^{-1}$ in the creek zone to an import of 77.44 μg-at m^{-2} $tide^{-1}$ in the marsh zone. Mean flux of ammonia in No Man's Friend was 1.525 μg-at

m^{-2} $tide^{-1}$. Carbon was typically exported in the bank and creek zone and imported in the marsh zone in No Man's Friend. Flux of carbon ranged from an export of 52.13 μg-at m^{-2} $tide^{-1}$ in the bank zone to an import of 23.68 μg-at m^{-2} $tide^{-1}$ in the marsh zone. Mean flux of carbon was 10.47 μg-at m^{-2} $tide^{-1}$. However, tests for means (Scheffe, SNK, and t) indicated that mean nutrient flux was not significantly different in these three zones.

All Three Locations

Analysis of variance on net flux in the three study sites, Oyster Landing, Town Creek, and No Man's Friend, showed that nutrient flux was correlated with direction of tidal flow (TD) in North Inlet. However, nutrient flux was not correlated with location (L) or zone within each location (S). Carbon flux was the exception; carbon was correlated with location (L) (PR>F = .0001), in addition to direction of tidal flow (PR>F = .0001). Nutrient flux of carbon was significantly affected by the interaction of L, S, and TD (PR>F = .0075), and interaction of L and S (PR>F = .0025).

Export of ortho-phosphate in North Inlet ranged from 8.091 μg-at m^{-2} $tide^{-1}$ in Oyster Landing to 4.99 μg-at m^{-2} $tide^{-1}$ in Town Creek. Figures 4.10 and 4.11 show net flux of nutrients during flood and ebb tide. Export of PO_4 from No Man's Friend was slightly higher than export from Town Creek, No Man's Friend contributed 5.70 μg-at m^{-2} $tide^{-1}$ to total export. Mean export of PO_4 in North Inlet was 6.26 μg-at m^{-2} $tide^{-1}$. Nitrate was exported from North Inlet, ranging from an export of 1.10 μg-at m^{-2} $tide^{-1}$ in Town Creek to 0.59 μg-at m^{-2} $tide^{-1}$ in No Man's Friend. Mean export of NO_3 was 0.86 μg-at m^{-2} $tide^{-1}$. Ammonia was exported from all three sites in North

Inlet, with the largest source being Oyster Landing. Export of ammonia ranged from 38.78 μg-at m^{-2} $tide^{-1}$ in Oyster Landing to 1.53 μg-at m^{-2} $tide^{-1}$ in No Man's Friend. Export was slightly higher in Town Creek than in No Man's Friend; Town Creek exported 4.01 μg-at m^{-2} $tide^{-1}$. Mean flux of ortho-phosphate, nitrate, and ammonia in these three locations was not significantly different (n=18, PR>F > 0.10).

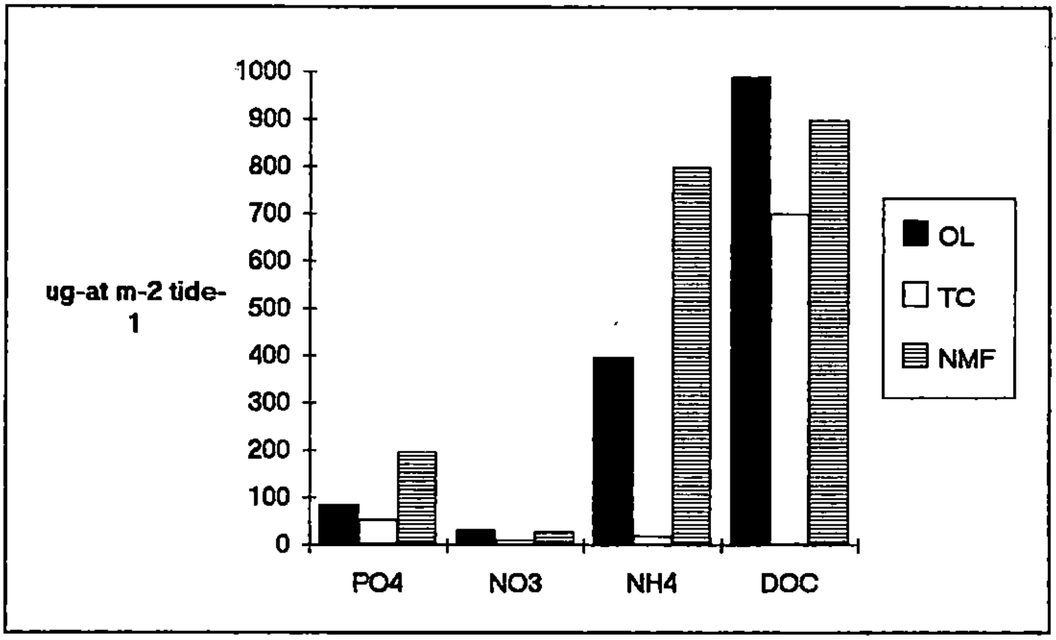

Figure 4.10. Net flux of nutrients in all three sites in North Inlet during flood tide. Positive values indicate export from the sediments in each location.

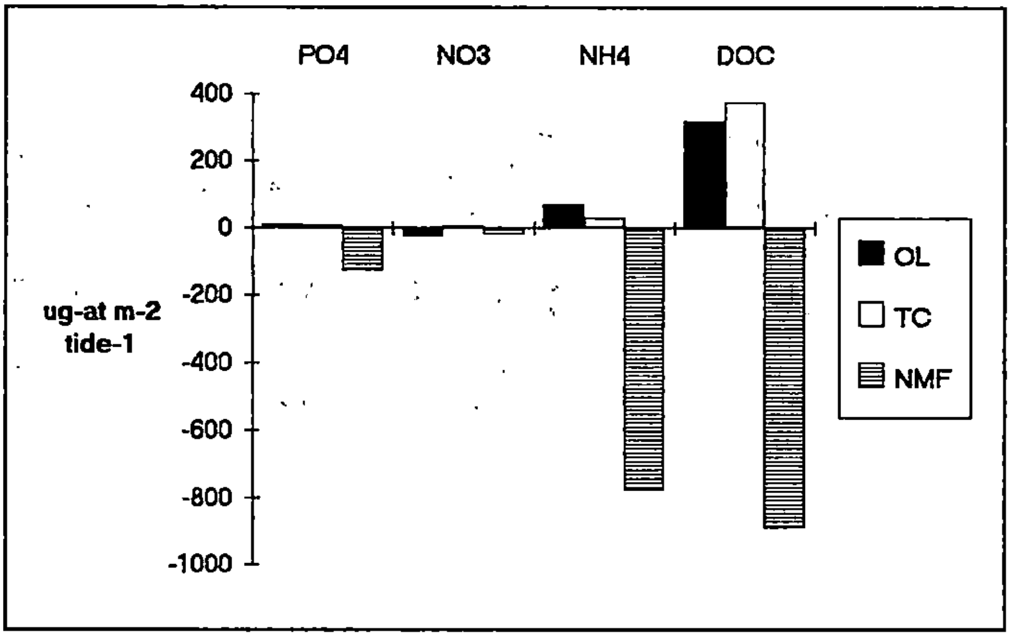

Figure 4.11. Net flux of nutrients in all three sites within North Inlet during ebb tide. Positive values indicate export from the system.

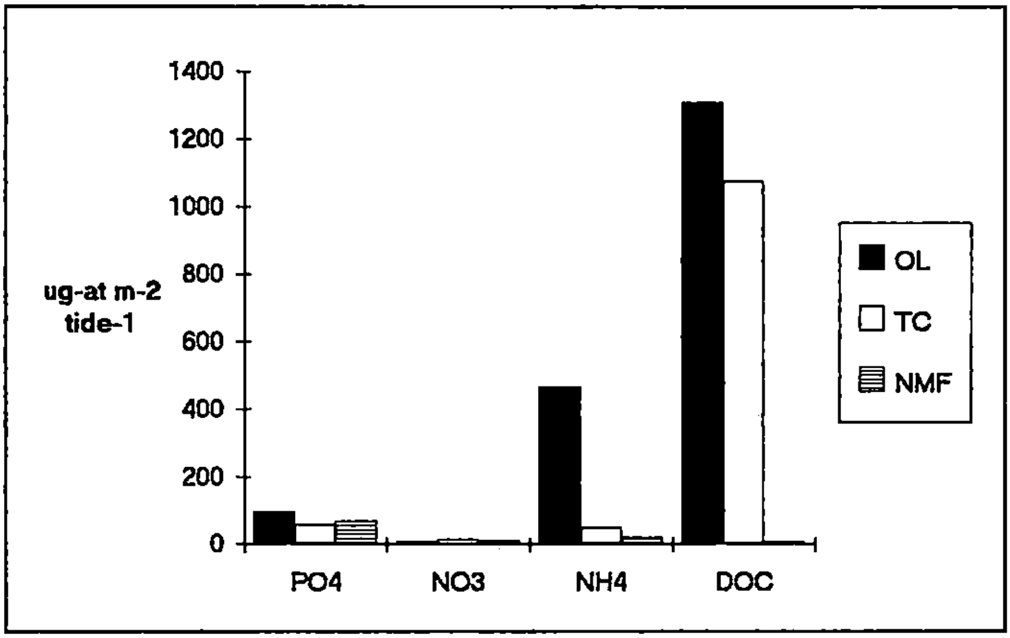

Figure 4.12. Overall net flux of nutrients from all three sites within North Inlet. Positive values indicate export from the system.

Nutrient Flux from Advective Flow Chambers

Oyster Landing

The following data represent average advective flow values derived from data in Appendix G. Since advective flow of nutrients was variable in volume, some observations did not have duplication. For this reason, duplicates were averaged and tabulated as single samples. Advective flow of nutrients contributed to total nutrient flux in Oyster Landing (Table 4.1). Figure 4.14 shows that phosphorus was exported predominantly in the bank zone (0.442 µg-at m^{-2} $tide^{-1}$), and to a lesser extent in the marsh zone (0.079 µg-at m^{-2} $tide^{-1}$). Total flux of ortho-phosphate was 0.731 µg-at m^{-2} $tide^{-1}$.

Table 4.1. Advective flow of nutrients in Oyster Landing. Concentrations are in µg-at m^{-2} $tide^{-1}$. Positive values indicate export from the sediments.

	Marsh	Bank	Creek	Total
PO4	0.079	0.442	0.210	0.731
NO3	0.841	0.900	3.570	5.311
NH4	5.166	3.000	13.800	21.966
DOC	2.399	5.570	26.597	34.566

Nitrate was exported through advective flow for a total flux of 5.311 µg-at m^{-2} $tide^{-1}$. Figure 4.14 shows that the majority of nitrate was advected in the creek zone (3.570 µg-at m^{-2} $tide^{-1}$), with a smaller contribution being made from the bank and marsh zones (0.841 and 0.900 µg-at m^{-2} $tide^{-1}$). Ammonia was exported primarily in the creek zone, with an advective flux of 13.800 µg-at m^{-2} $tide^{-1}$. Advective flux of ammonia ranged from 3.000 μg-at m^{-2} $tide^{-1}$ in the marsh zone to 5.166 μg-at m^{-2} $tide^{-1}$ in the bank zone.

Dissolved organic carbon exhibited the largest advective flux in Oyster Landing. Total DOC advected in this site was 34.566 μg-at m^{-2} $tide^{-1}$, with a range of 2.399 μg-at m^{-2} $tide^{-1}$ in the marsh zone to 26.597 μg-at m^{-2} $tide^{-1}$ in the creek zone. The bank zone contributed 5.570 μg-at m^{-2} $tide^{-1}$.

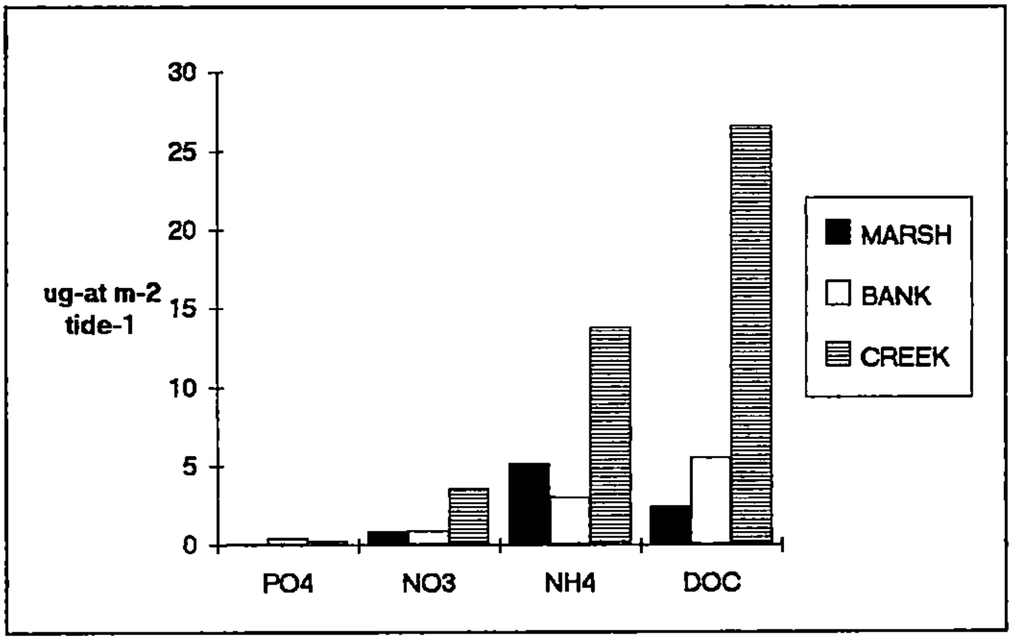

Figure 4.13. Advective flow in Oyster Landing. Positive values indicate export from the sediments.

Town Creek

Advective flow in Town Creek contributed to total nutrient flux in this site. Total export of ortho-phosphate was 19.960 μg-at m^{-2} $tide^{-1}$, ranging from .680 μg-at m^{-2} $tide^{-1}$ in the marsh zone to 18.490 μg-at m^{-2} $tide^{-1}$ in the creek zone (Table 4.2).

Table 4.2. Advective flow of nutrients in Town Creek. Units are µg-at m^{-2} $tide^{-1}$. Positive values indicate export from sediments.

	Marsh	Bank	Creek	Total
PO4	0.680	0.790	18.490	19.960
NO3	0.350	0.230	1.000	1.580
NH4	35.100	8.690	48.500	92.290
DOC	7.670	3.030	4.310	15.010

Nitrate was exported through advective flow, with a total flux of 1.580 µg-at m^{-2} $tide^{-1}$, ranging from 0.350 µg-at m^{-2} $tide^{-1}$ in the marsh zone to 1.000 µg-at m^{-2} $tide^{-1}$ in the creek zone (Fig. 4.15). Ammonia nitrogen was exported to a greater extent from the marsh and bank zones, with a total flux of 92.290 µg-at m^{-2} $tide^{-1}$. The range of ammonia flux was 35.100 µg-at m^{-2} $tide^{-1}$ in the marsh zone to 48.500 µg-at m^{-2} $tide^{-1}$ in the creek zone.

Dissolved organic carbon was exported through advective flow for a total of 15.010 µg-at m^{-2} $tide^{-1}$. The majority of DOC was exported from the marsh zone (7.670 µg-at m^{-2} $tide^{-1}$), and to a lesser extent from the bank zone (3.030 µg-at m^{-2} $tide^{-1}$).

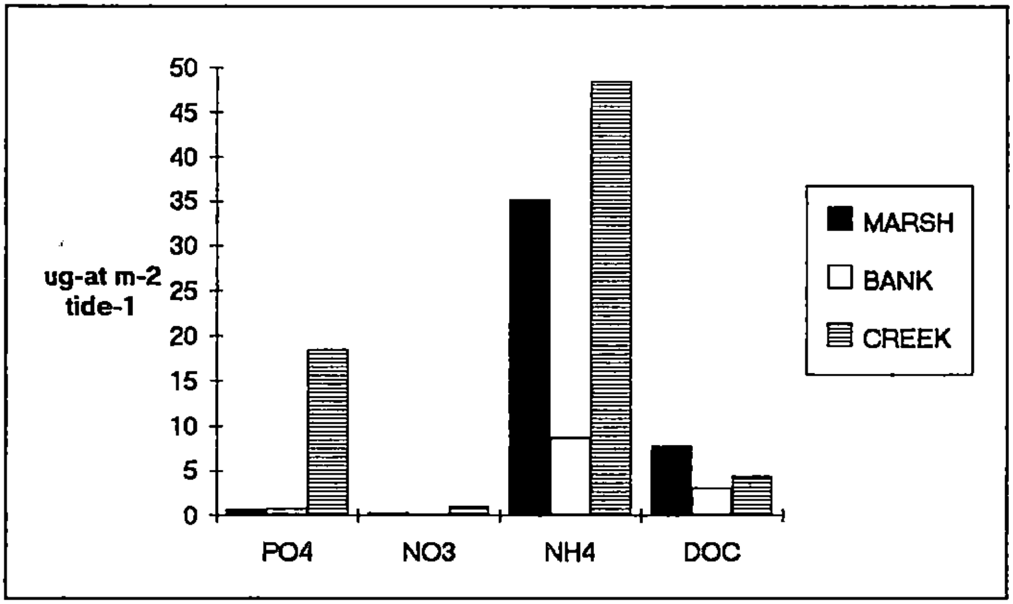

Figure 4.14. Advective flux from Town Creek. Positive values indicate export from the sediments.

<u>No Man's Friend</u>

Advective flow contributed to total nutrient flux in No Man's Friend. Ortho-phosphate was exported through advective flow for a total of 1.180 μg-at m^{-2} $tide^{-1}$. The primary source of ortho-phosphate was the creek zone (0.740 μg-at m^{-2} $tide^{-1}$) with a minor contribution being made by the marsh zone (0.140 μg-at m^{-2} $tide^{-1}$). Table 4.3 shows the mean nutrient flux in No Man's Friend.

Table 4.3. Advective flow of nutrients in No Man's Friend. Units are μg-at m^{-2} $tide^{-1}$, and positive values indicate export from the sediments.

	Marsh	Bank	Creek	Total
PO4	0.140	0.300	0.740	1.180
NO3	1.428	1.570	2.440	5.438
NH4	1.111	9.980	29.400	40.491
DOC	0.820	1.930	3.190	5.940

Nitrate was exported through advective flow for a total flux of 5.438 μg-at m^{-2} $tide^{-1}$. The majority of NO_3 was exported from the creek zone (2.440 μg-at m^{-2} $tide^{-1}$), with a smaller contribution from the marsh zone of 1.428 μg-at m^{-2} $tide^{-1}$ (Figure 4.16). Ammonia was also exported in No Man's Friend; total advective flow was 40.491 μg-at m^{-2} $tide^{-1}$. The creek zone contributed the majority of NH_4, with a minor contribution being made by the marsh and bank zone.

Dissolved organic carbon was exported through advective flow in No Man's friend. Total advective flux of DOC was 5.940 μg-at m^{-2} $tide^{-1}$. The creek zone contributed the largest flux (3.190 μg-at m^{-2} $tide^{-1}$), with a lesser amount (0.820 μg-at m^{-2} $tide^{-1}$) being contributed by the marsh zone.

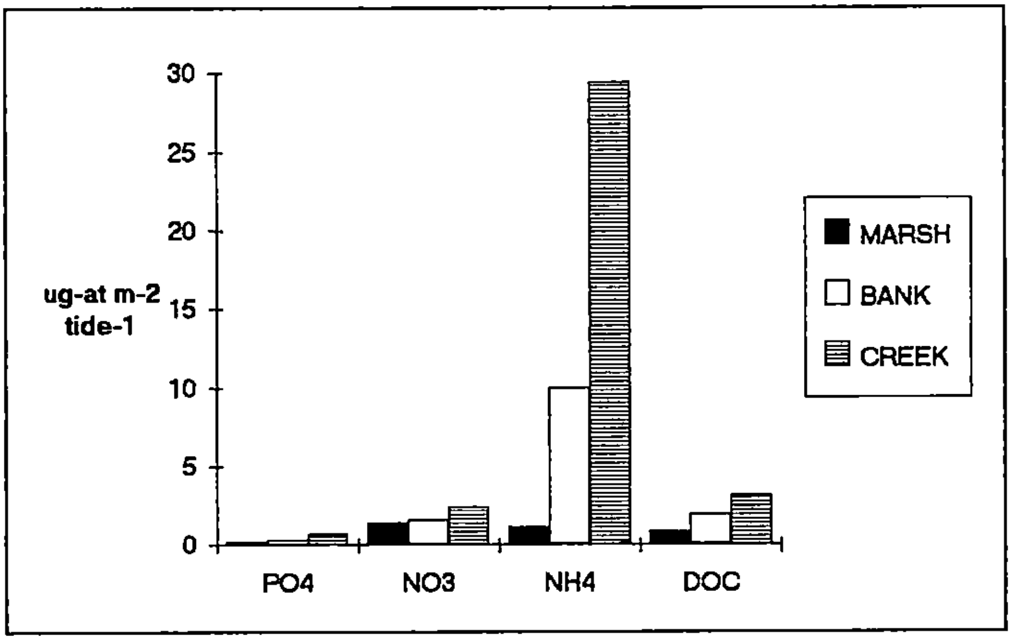

Figure 4.15. Advective flow in No Man's Friend. Positive values indicate export from the sediments.

<u>All Three Sites</u>

Figure 4.16 shows net advective flux in North Inlet. In all sites (OL, TC, NMF), all nutrients were exported through advective flow. Town Creek exhibited the largest flux of NH_4^+ and PO_4^{-3}, and the lowest flux of NO_3^-. The major source of DOC came from Oyster Landing, followed by Town creek and No Man's Friend. Oyster Landing and No Man's Friend contributed similar amounts of NO_3^-. Overall, ammonia was the largest export in North Inlet, followed by dissolved organic carbon. Additionally, Oyster Landing was the major source of advected nutrients, followed by No Man's Friend.

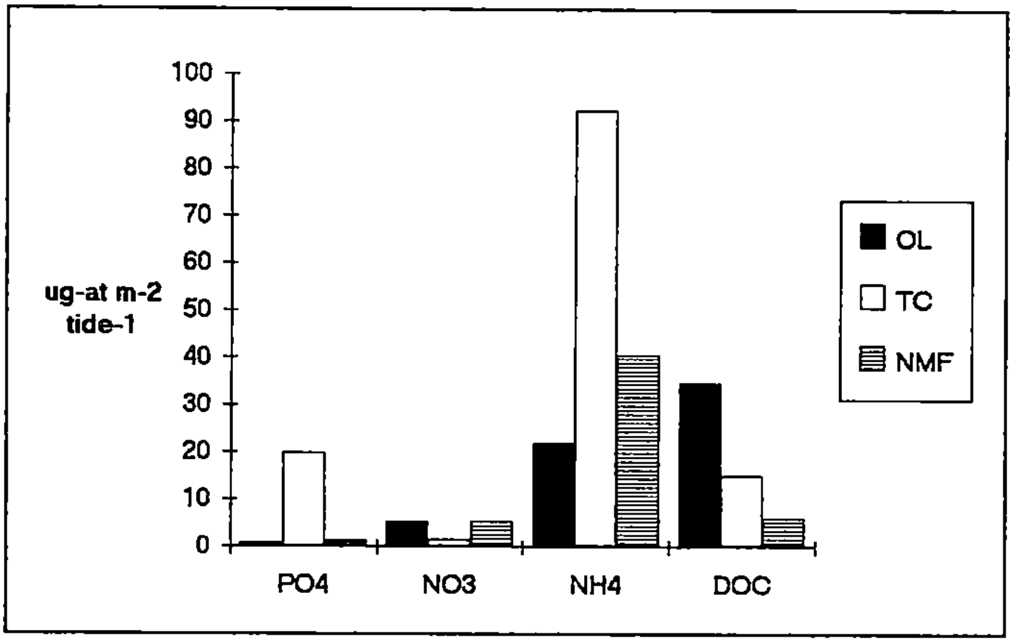

Figure 4.16. Net advective flux in all three sites in North Inlet. Positive values indicate export from the sediments.

Nutrient Flux from Benthic and Advective Flow Chambers

Oyster Landing

Nutrient flux from both benthic and advective flow chambers contributed to total nutrient export in Oyster Landing. Mean nutrient data for both chamber types is listed in table 4.4. Means were further separated by chamber type and zone within Oyster Landing.

Table 4.4. Benthic and advective nutrient flux in Oyster Landing. Positive values indicate export from the sediments. Values are in µg-at m^{-2} $tide^{-1}$.

	BENTHIC CHAMBER			ADVECTIVE CHAMBER		
	MARSH	BANK	CREEK	MARSH	BANK	CREEK
PO_4^{-3}	30.838	18.997	47.259	0.079	0.442	0.210
NO_3	13.707	16.839	-23.365	0.841	0.900	3.570
NH_4^+	307.847	68.632	88.927	5.166	3.000	13.800
DOC	592.718	393.678	320.936	2.399	5.570	26.597

Typically, nutrient flux from benthic flow chambers was higher than nutrient flux from advective chambers in Oyster Landing (Figure 4.18). However, analysis of variance made on these data indicated that only for DOC was mean benthic and advective flux was significantly different. The PR>F value for this nutrient was in the decision range (PR>F=.0399). Scheffe's, SNK, and t tests, however, supported the conclusion that mean carbon flux in the two chamber-types was significantly different.

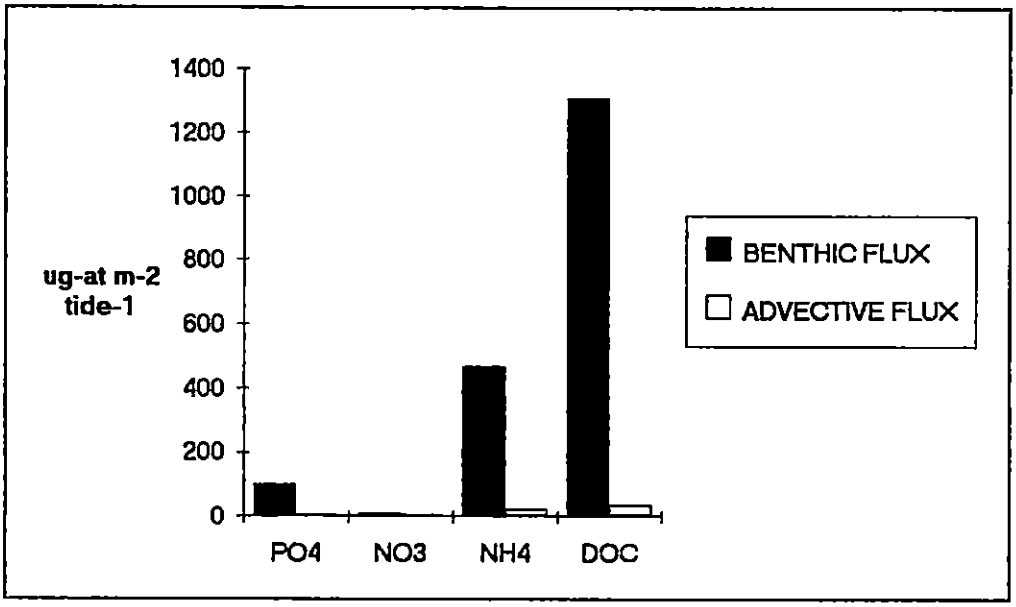

Figure 4.17. Nutrient flux from benthic and advective flux chambers in Oyster Landing. Positive values indicate export from the sediments.

<u>Town Creek</u>

Nutrient flux in Town Creek, a geologically old tidal creek, was influenced by both benthic and advective flux (Table 4.5). Clearly, from this data and Figure 4.18, benthic flux was greater than advective flux in this tidal creek, with the exception of NH_4^+.

Table 4.5. Nutrient flux in Town Creek from benthic and advective flow chambers. Positive values indicate export from the sediments. Units are μg-at m^{-2} tide^{-1}

	BENTHIC CHAMBER			ADVECTIVE CHAMBER		
	MARSH	BANK	CREEK	MARSH	BANK	CREEK
PO_4^{-3}	11.372	22.092	26.510	0.680	0.790	18.483
NO_3^-	3.932	4.913	4.350	0.350	0.230	1.000
NH_4^+	5.221	48.451	-5.520	35.100	8.690	48.500
DOC	168.584	325.329	583.120	7.670	3.030	4.310

However, analysis of variance indicated that benthic and advective nutrient flux was only significantly different for NO_3^- (PR>F=.0111). Significant difference of mean NO_3^- flux from the two chamber types was supported by Scheffe's, SNK, and t tests. Mean flux of PO_4^{-3}, NH_4^+, and DOC was not significantly different.

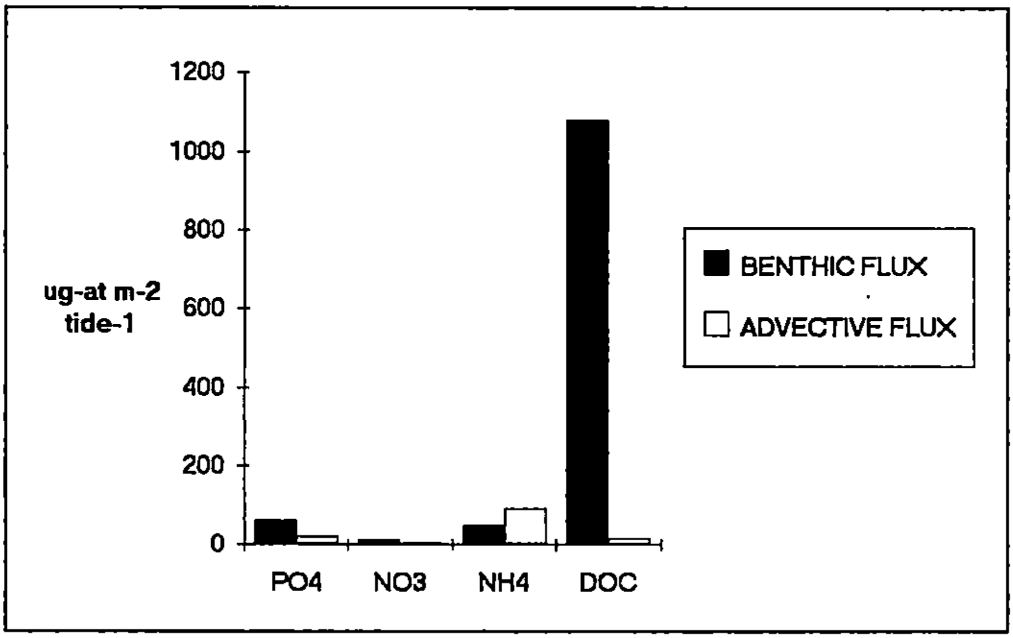

Figure 4.18. Nutrient flux from benthic and advective flux chambers in Town Creek. Positive values indicate export from the sediments.

No Man's Friend

No Man's Friend, an intermediate-age tidal creek, had nutrient flux to which both benthic and advective flux contributed. Table 4.6 lists mean nutrient flux values from both chamber types in No Man's Friend. Nutrient flux data from the marsh zone in No Man's Friend from benthic chambers indicate that this zone was a sink for nutrients.

Nutrient flux from the advective flux chambers, however, was always positive, indicative of export.

Table 4.6. Nutrient flux from benthic and advective flow chambers in No Man's Friend. Positive values indicate export. Units are µg-at m^{-2} $tide^{-1}$.

	BENTHIC CHAMBER			ADVECTIVE CHAMBER		
	MARSH	BANK	CREEK	MARSH	BANK	CREEK
PO4	-29.306	29.709	68.844	0.140	0.300	0.740
NO3	0.749	3.115	6.083	1.428	1.570	2.440
NH4	-309.753	-30.861	359.835	1.111	9.980	29.400
DOC	-367.106	12.909	361.233	0.820	1.930	3.190

Figure 4.19 shows that, for all nutrients except NH_4^+, benthic nutrient flux was greater than advective nutrient flux. An especially high difference was seen in PO_4^{-3} flux; nutrient flux from benthic chambers was thirty-five times higher than flux from advective flow chambers. However, analysis of variance indicated that there was no significant difference between mean nutrient flux from the two chamber types.

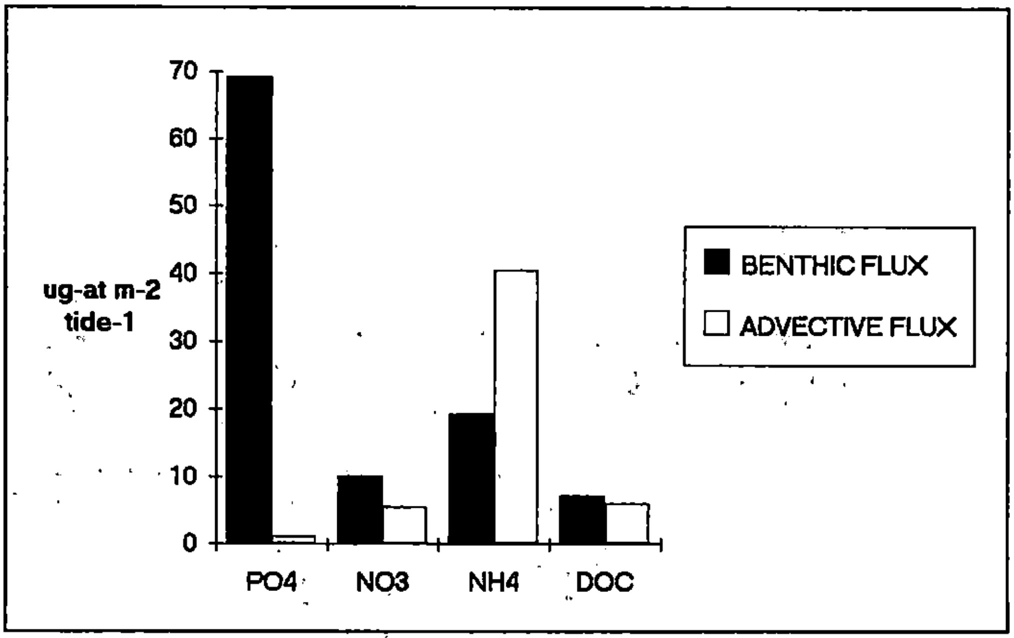

Figure 4.19. Nutrient flux from benthic and advective flow chambers in No Man's Friend. Positive values indicate export from the sediments.

<u>**Total Flux from All Three Sites**</u>

Total nutrient flux in North Inlet, S.C., was determined by combining flux from each zone in OL, TC, and NMF tidal creeks. Table 4.7 lists summary data for total flux, further separated into total advective and total benthic nutrient flux. Totals for both chamber types were calculated by adding nutrient flux in each of the three zones in each tidal creek. This data were discussed fully in a previous section.

Table 4.7. Nutrient flux from benthic (B) and advective (A) flux chambers. Units are μg-at m^{-2} tide $^{-1}$. Positive values indicate export from the sediments.

	OL		TC		NMF	
	B	A	B	A	B	A
PO_4^{-3}	97.094	0.731	59.974	19.953	69.247	1.180
NO_3^-	7.181	5.311	13.195	1.580	9.947	5.438
NH_4^+	465.406	21.966	48.152	92.290	19.221	40.491
DOC	1307.332	34.566	1077.033	15.010	7.036	5.940

In all three sites, nutrient flux from benthic chambers was higher than nutrient flux from advective flux chambers. Total nutrient flux in each tidal creek was calculated by adding benthic flux from all three tidal creeks, then adding all three nutrient fluxes from advective flux chambers. Table 4.8 lists total nutrient flux from the two chamber types in North Inlet.

Total nutrient flux from benthic chambers was typically higher than flux from advective flow chambers. Figure 4.20 shows that, especially for DOC, benthic remineralization predominated over advective flux in North Inlet. However, analysis of variance indicated that only PO_4^{-3} and NO_3^- flux was significantly different between the two chamber types (PR>F = .0058 and .0209, respectively). Significant difference was supported by Scheffe's, SNK, and t tests. Mean flux of NH_4^+ and DOC was not significantly different in the two chamber types.

Table 4.8. Total nutrient flux from benthic and advective flux chambers in North Inlet. Units are µg-at m^{-2} tide $^{-1}$. Positive values indicate export from the sediments.

	Benthic	Advective
PO4	226.3152	21.864
NO3	30.323	12.329
NH4	532.779	154.747
DOC	2391.401	55.516

Nutrient flux from both chamber types was combined to estimate total nutrient flux in each tidal creek. Overall, Oyster Landing exhibited the largest export of nutrients, followed by Town Creek and No Man's Friend (Figure 4.20). Analysis of variance indicated that total nutrient flux from benthic and advective chambers was not significantly different in all three sites; therefore, these means were considered collectively.

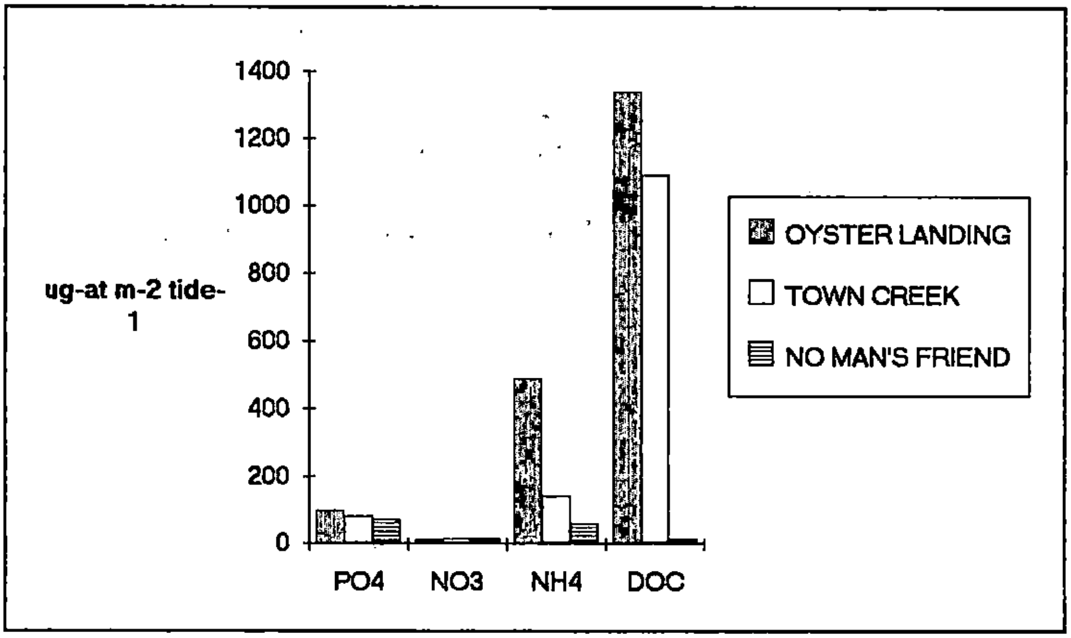

Figure 4.20. Total nutrient flux (benthic + advective) in all three sites in North Inlet. Units are μg-at m^{-2} $tide^{-1}$. Positive values indicate export from the sediments.

Since advective nutrient flux contributed little to total nutrient flux in North Inlet, discussion of within and between site variability, is the same as that previously discussed. Combining nutrient flux data from both chamber types and from all three tidal creeks provides a summary of nutrient flux in North Inlet. Tidal creeks in this estuarine salt marsh exported all nutrients studied (Figure 4.21). Carbon export was very high, followed in magnitude by NH_4^+, PO_4^{-3}, and NO_3^-. Total flux of these nutrients in North Inlet are summarized in Table 4.9.

Table 4.9. Total nutrient flux in North Inlet.

PO4	248.1792	μg-at m^{-2} tide^{-1}
NO3	42.652	μg-at m^{-2} tide^{-1}
NH4	687.526	μg-at m^{-2} tide^{-1}
DOC	2446.917	μg-at m^{-2} tide^{-1}

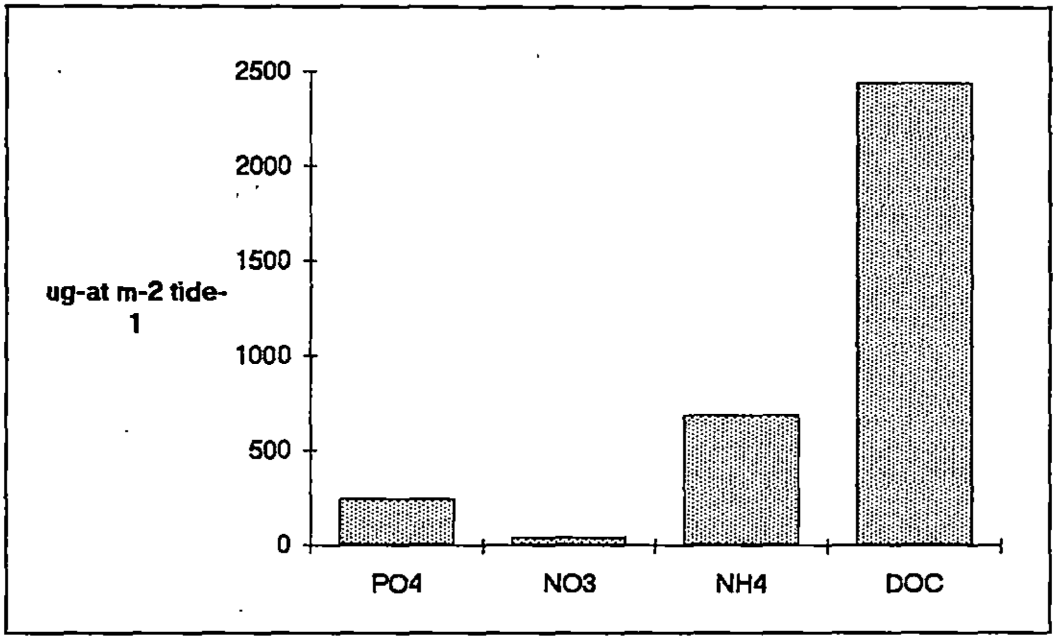

Figure 4.21. Total nutrient flux in North Inlet. Positive values indicate export from the sediments.

CHAPTER V
DISCUSSION

The Effect of Geological Age of Tidal Creeks on Nutrient Flux

The movement and cycling of nutrients in North Inlet tidal creeks exhibit variability in relation to the geologic age of the creeks. Dame et al. (1991) hypothesized that geologically-young tidal creeks import nutrients, and geologically-old creeks export nutrients. Wolaver and Spurrier (1988) supported the hypothesis; they found that Bly Creek, S.C., (a young system) functioned as a sink for NO_3^- and NH_4^+. However, Bly Creek's sandy sediments probably had little capacity for nutrient absorption.

Data collected in North Inlet, S.C. contradict this hypothesis. Oyster Landing, a geologically young tidal creek, exported PO_4^{-3}, NO_3^-, NH_4^+, and D.O.C. Additionally, nutrient export from Oyster Landing was greater than nutrient export from the two geologically older study sites in North Inlet. No Man's Friend, an intermediate-age tidal creek, exported only NH_4^+ and DOC in statistically-significant amounts. However, the export of nutrients from No Man's Friend was less than the export on nutrients from the other two study sites. The geologically-old tidal creek studied, Town Creek, exported all nutrients examined, although the magnitude of nutrient export was intermediate between the young- (Oyster Landing) and intermediate- (No Man's Friend) age tidal creeks. Figure 5.1 shows changes in nutrient export in relation to geological age.

It is my contention that young tidal creeks begin their evolution with an abundance of nutrients. In a transgressive system, such as North Inlet, new tidal creeks are formed over old forest sediments as a response to sea level rise. These formerly terrestrial sediments have accumulated nitrogen and phosphorus, but little organic matter and clay. Therefore, young tidal creek sediments easily release nutrients into nutrient-poor oceanic water.

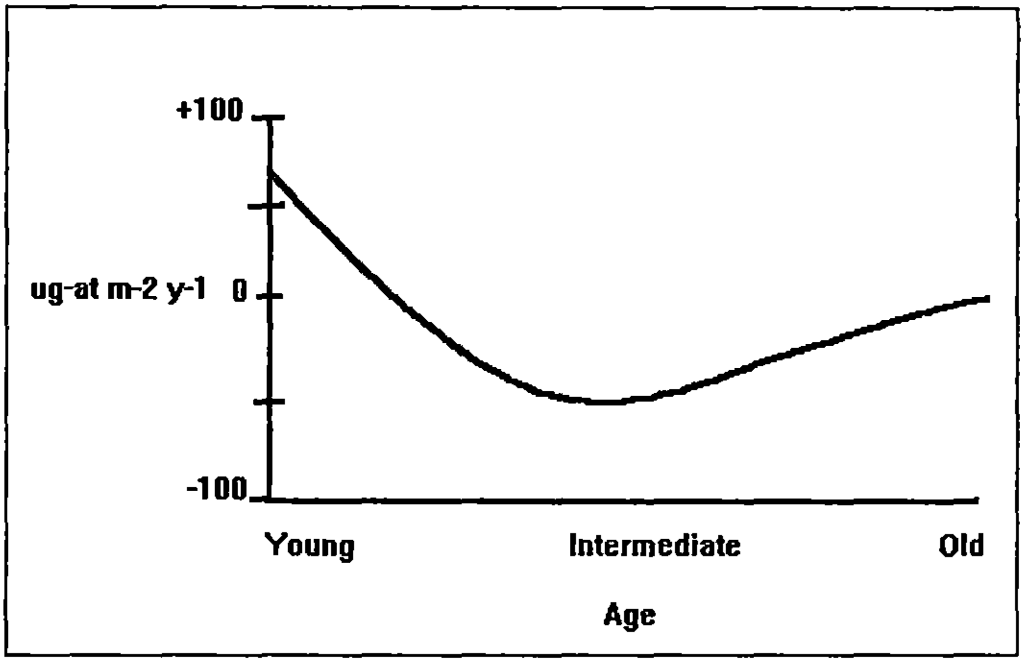

Figure 5.1. Schematic diagram of nutrient export in relation to geologic age. Positive values indicate export from the sediments.

As tidal creeks mature, organic matter and fine silts and clays accumulate in the sediments. Therefore, intermediate-age tidal creeks have a greater capacity for nutrient retention. Nutrient-poor oceanic water flooding the tidal creeks will, however, always produce a concentration gradient. Nutrients would, in response to flooding, be leached from the sediments. They would be lost through sediment scour resulting from increasing tidal velocity.

Over time, tidal creeks would be stripped of nutrients and small-size sediments in response to continuing tidal scour. Tidal scour would, in turn, decrease the capacity of these creeks to retain nutrients. As these tidal creeks reach old-age, nutrients could be completely stripped from the sediments.

Effect of Tidal Flow Direction on Nutrient Flux

Nutrient flux in tidal creeks in North Inlet, S.C. is strongly dependent upon the direction of tidal flow. During flood tide, nutrient-poor oceanic water inundates tidal creek sediments, producing a strong nutrient concentration gradient. High flow velocity during flood tide scours the sediments, resuspending smaller size particles (Nakata 1980). Resuspension, in turn, increases contact time between absorbed nutrients and the water column. As tidal water recedes, suspended sediments fall out of solution, and bury absorbed nutrients. Additionally, absorption-desorption processes would be at equilibrium, although some nutrients may be absorbed if sufficient small-particle resuspension occurs.

During flood tide, tidal creeks of all three geologic ages in North Inlet release nutrients into the water column. The geologically-young tidal creek, Oyster Landing, exhibits the largest flux of nutrients, followed in magnitude by No Man's Friend and Town Creek. However, nutrient flux between these three geologically-aged tidal creeks is not significantly different ($n=18$, $PR>F > .10$). During ebb tide, both the young (Oyster Landing) and old (Town Creek) tidal creeks export nutrients. The largest export is evident in the young system, Oyster Landing. No Man's Friend, the geologically intermediately-aged tidal creek, imports nutrients during ebb tide. The majority of import is in the creek zone, with a smaller contribution being made by the bank zone. The marsh zone in No Man's Friend exports nutrients on ebb tide. High nutrient flux in No Man's Friend, an intermediate-age tidal creek, may be due to absorption-desorption phenomena acting on sediments that have accumulated, through time, a large amount of nutrients.

Effect of Tidal Creek Zonation on Nutrient Flux

The magnitude and direction of nutrient flux in tidal creeks are variable in relation to zonation patterns characteristic of these creeks. In the marsh zones, organic matter typically accumulates, and small-size particles are trapped by vegetation. Since these small particles have a large surface area, one would expect them to absorb significant amounts of nutrients. The bank zone represent a transition between the creek and marsh zones in relation to nutrient concentrations and sediment composition (Reeder et al., in press). Tidal scour and leaching strips this zone of nutrients, while inputs from the marsh surface replenish the supply of nutrients and sediments.

Sediments in the middle of tidal creeks are in a high-energy area, and are under the influence of constant tidal scour. Because of high tidal velocity, smaller sediment particles are exported from this zone, perhaps to the marsh surface, during flood tide. As the tide recedes, these particles are deposited in the marsh zone. Since the creek zones are constantly in contact with nutrient-poor oceanic water, sediments in these zones export nutrients. Additionally, creek zones have little absorptive capacity, due to the paucity of small-sediment particles, such as clays.

In tidal creeks of North Inlet, S.C., both geologically-young (Oyster Landing) and geologically-old (Town Creek) tidal creeks export nutrients from all three zones. The marsh zone exports nutrients in Oyster Landing and Town Creek, but imports nutrients in No Man's Friend, the intermediate-age tidal creek. Isotherm studies of tidal creek sediments, conducted by Reeder et al. (in press), indicate that marsh sediments in No Man's Friend have a greater capacity for nutrient absorption than do sediments in Oyster Landing and Town Creek. Since the absorptive capacity in Oyster Landing and Town Creek are relatively small, it is hypothesized that a large concentration gradient between absorbed nutrients and the water column drive nutrient export in Oyster Landing and Town Creek.

The deeper creek zones, in all three geologically-aged tidal creeks, exports all nutrients studied. The creek zone in Town Creek, the geologically-old tidal creek, shows the largest export of DOC and NH_4^+, followed in magnitude by export from No Man's Friend and Oyster Landing. The creek zones, in all three geologically-aged tidal creeks, export both NO_3^- and PO_4^{-3}; however, the export of both NO_3^- and PO_4^{-3} are not significant.

Contribution of Benthic and Advective Flux to Total Nutrient Export

Whiting et al. (1987) suggested that nutrient flux in tidal creeks was a function of two phenomena, advection and benthic remineralization. Also, Whiting and Childers (1989) found that advective flux was the major pathway for nutrient movement; with other sources making minor contributions to movement. Using the work of previous investigators, both factors were studied in tidal creeks of North Inlet, S.C. Table 5.1

lists advective flow values in Bly Creek, S.C., investigated by Whiting and Childers (1989), and data collected during this study in North Inlet. Overall advective nutrient flux is calculated as the sum of advective flux in the three tidal creeks studied.

Data presented in Table 5.1 support the contention that nutrient export in tidal creeks is a function of advective nutrient flow. Values derived from studies made in Bly Creek, S.C. (Whiting and Childers 1989), correspond to data collected during this study; the exception being the magnitude of NH_4^+ export. Export of DOC was not examined in Bly Creek.

Table 5.1. Comparison of advective flow data from the present and previous studies (Bly Creek, S.C., Whiting and Childers (1989)). Values are in µg-at m^{-2} $tide^{-1}$. Positive values indicate export from the sediments.

Source	PO_4^{-3}	NO_3^-	NH_4^+	DOC
Bly Creek	10.01	1.43	221.32	no data
Oyster Landing	0.731	5.311	21.966	34.566
No Man's Friend	1.180	5.44	40.49	5.94
Town Creek	19.95	1.58	92.29	15.01
Overall North Inlet	21.86	12.33	154.75	55.52

Bly Creek is a geologically-young tidal creek, and nutrient values derived for advective flow should correspond to values found in Oyster Landing. However, advective nutrient flux in Bly Creek corresponds more closely to that of Town Creek, a geologically old tidal creek. Whiting and Childers (1989) also reported NH_4^+ flux one order of magnitude higher than results supported from this study. It is possible that the

NH_4^+ flux reported by Whiting and Childers (1989) was high due to the effect of artificially-induced anoxia produced in the sealed chambers.

Data collected in North Inlet during this study supports the conclusion that anoxic release of NH_4^+ occurs in advective chambers, although release was minimal, with the exception of No Man's Friend. The basis for this conclusion is as follows. Release of NH_4^+ from sediments under aerobic conditions should be the by-product of the decomposition of organic matter. Thus, the magnitude of ammonia release should correspond to the release of dissolved organic carbon. In Oyster Landing, the geologically-young tidal creek, NH_4^+ and DOC exports were similar in magnitude, supporting this conclusion. In the progression from shallower to deeper tidal creeks, oxygen levels may decrease corresponding to water depth; anoxic NH_4^+ release should be greater in deeper creeks. This conclusion holds true for No Man's Friend and Town Creek, which had greater mean depths than Oyster Landing. Since DOC was not studied in Bly Creek, there are no data to support, or refute, this conclusion. However, considering that ammonia flux was an order of magnitude greater in the Bly Creek Study, one could assume that anoxic conditions within the advective chambers remobilized NH_4^+, and contributed, significantly, to the observed flux of this nutrient.

Nutrient Outwelling in North Inlet Tidal Creeks

Odum and de la Cruz (1967) hypothesized that, as highly productive ecosystems, estuarine salt marshes produce an excess of nutrients. These excess nutrients could be "outwelled", or exported, to the adjacent continental shelf, and feed coastal ecosystems. Nixon (1980) summarized 20 years of outwelling research; he concluded that estuarine salt marsh systems export nutrients to the adjacent ocean. However, he noted that this export was typically small.

Table 5.1 lists average nutrient export values extracted from Tables 2.1, 2.2, 2.3 from Chapter 2, and data collected from North Inlet in this study. Yearly flux was estimated by multiplying daily net flux by 365; flux values were assumed to be indicative of annual trends. Data presented in Table 5.1. indicate that estuarine salt marshes export nutrients. Export values determined by this study are well within the range of those produced in previous studies, and they tend to support the "outwelling" hypothesis for nutrient flux in tidal creeks of North Inlet, S.C. Additionally, these data support the contention that contributions to nutrient "outwelling", made by tidal creeks of different ages, are variable. Specific contributions made by tidal creeks of different geologic ages must be examined to understand fully sediment-water nutrient flux in estuarine salt marsh systems.

Table 5.2 Nutrient flux from outwelling studies. Values are in g m^{-2} yr^{-1}. Positive values indicate export from the salt marsh system to the ocean.

Source	PO_4^{-3}	NO_3^-	NH_4^+	DOC
Previous Studies	1.48	-0.10	1.79	47.82
Oyster Landing	2.14	0.12	4.83	11.40
No Man's Friend	1.75	0.15	1.39	9.27
Town Creek	1.54	0.15	0.59	0.11
Overall North Inlet	5.43	0.42	6.81	20.78

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

Nutrient cycling in estuarine salt marshes is strongly influenced by tidal creek nutrient dynamics. Geologic age, direction of tidal flow, tidal creek zonation patterns, and hydrologic position all affect net movement of nutrients in North Inlet. Additionally, all three tidal creek types in North Inlet export nutrients, although magnitude of flux is variable. Geologically-young tidal creeks are highly productive, and thus release excess nutrients. As these tidal creeks age, organic matter and small particles, as well as nutrients, accumulate in the sediments. In turn, these intermediate-age tidal creeks have a high capacity for nutrient import and export. As sea level rises, intermediate-age tidal creeks are strongly affected by the ocean. Tidal scour and desorption into nutrient poor oceanic water strip these sites of nutrients. Therefore, geologically old tidal creeks have little capacity to import and export nutrients.

It is recommended that geologic age be considered when studying nutrient import-export in tidal creek ecosystems. However, age should be considered both ecologically and geologically, rather than just geologically. Nutrient export must include contribution of nutrients through benthic remineralization and advective flow, as both processes contribute to total nutrient export. Additionally, different zones in tidal creeks must be examined, as they are highly variable in their contribution to total nutrient movement.

Although a significant amount of sediment data was collected during this study, analyses of this data was not completed. It would be interesting to determine the effect of sediment type on total nutrient import and export in these tidal creeks. Study of the cause and effect relationship between sediment types and nutrient cycling may introduce new insight into the process of nutrient regeneration in tidal creeks. Also, it has been suggested that time may play an important role in tidal creek nutrient flux. Examination of diurnal nutrient flux may enhance the understanding of nutrient movement in estuarine salt-marsh tidal creeks.

CHAPTER VII

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CHAPTER VIII.

APPENDICES

APPENDIX A. Sediment Data From North Inlet

1. Oyster Landing

DISTANCE FROM SHORE

	0	2	4	6	8	10	12	14	16	18	20	22	24
Z	0	15	67	83	75	81	87	95	86	54	72	73	35
SN	62.9	76.6	88.5	78	95.6	95.4	93	93.5	95.5	93.2	93.3	87.8	93
SL	28.4	12.9	2.5	11	1.4	0.6	0.5	1	0	0.3	1.7	4.2	3
CL	8.7	10.5	9	11	3	4	6.5	5.5	4.5	6.5	5	8	4
BD	0.266	0.396	0.637	0.409	0.982	1.015	1.181	1.159	1.088	1.155	1.068	0.746	1.041
OM	15.51	9.78	6.23	9	1.34	1.09	0.49	7.82	0.81	0.85	0.84	4.32	1.93
CO	4.79	2.35	2.06	3.08	0.56	0.295	0.643	0.278	0.404	0.571	0.306	0.203	1.92
MP	54	76	80	56	61	43	32	59	54	58	73	34	38
MK	475	500	421	268	278	250	247	416	466	500	500	500	500
CA	950	1230	1320	940	790	530	410	880	910	2910	1760	3850	5130
MG	496	969	486	367	363	325	328	544	529	1792	1235	2075	2441
TKN	247.8	484.3	242.8	183.5	181.3	162.5	163.8	271.8	264.5	896	617.9	1037	1220
EQP	116.62	435.64	1265.42	1113.37	257.69	403.65	486.69	228.17	262.84	288.28	132.26	26.58	31.72
SP	-140.41	-970.17	-358.62	-733.71	306.95	-304.36	-99.72	-122.80	-149.95	-248.21	-128.12	-60.42	-55.41

APPENDIX A. (cont.)

2. Town Creek

DISTANCE FROM SHORE

	0	10	20	30	40	50	60	70	80	90	100
Z	0	35	60	71	73	73	67	51	32	0	0
SN	71.5	91.5	94	95.8	92.5	96	92	91.7	96	96	92.3
SL	18.5	3.5	0	0.2	0	0	0.5	1.3	0	0	7
CL	10	5	6	4	7.5	4	7.5	7	4	4	0.7
BD	0.456	0.71	0.924	0.946	1.019	1.003	0.919	0.905	0.927	0.899	0.915
OM	12.4	3.75	1.83	1.34	0.86	1.06	1.08	1.51	1.28	0.99	1.35
CO	3.48	3.15	1.66	1.25	1.58	1.32	1.64	1.56	1.52	1.77	1.72
MP	55	35	33	23	23	17	18	18	20	16	29
MK	500	500	500	381	425	337	445	355	443	448	436
CA	8660	8740	10490	10660	9110	9250	9150	12000	10770	14470	13580
MG	1960	799	630	491	532	448	584	578	436	544	486
TKN	980	399.6	315	245.3	265.8	223.8	292	289	218	272	242.8
EQP	432.492	15564.8	276.719	217.424	256.036	204.124	59.469	414.146	528.068	683.965	1615.08
SP	-391.97	-162.81	-400.41	-250.69	-200.86	-232.91	-36.71	-335.46	-205.26	-175.78	-186.22

APPENDIX A. (cont.)

3. No Man's Friend

DISTANCE FROM SHORE

	0	10	20	30	40	50	90	100
Z	23	35	47	100	125	155	103	102
SN	51.1	52.3	59.4	65	53.6	64	59.4	65
SL	38.2	37.7	32.6	26	36.4	28	32.6	26
CL	10.7	10	8	9	10	8	8	9
BD	0.262	0.231	0.289	0.283	0.328	0.283	0.306	0.315
OM	16.12	14.8	12.43	13.51	12.69	10.91	12.13	12.67
CO	3.99	4.28	2.43	4.15	4.14	3.97	5.57	7.23
MP	29	14	26	14	65	108	70	99
MK	475	500	500	500	500	500	500	2786
CA	3750	4570	5600	6170	4000	3650	3990	2490
MG	2387	2603	2576	2665	2497	2118	2501	2183
TKN	1194	1301	1288	1332	1249	1059	1250	1092
EQP	43.824	31.513	51.976	47.548	23.203	13.723	15.214	15.149
SP	-941.511	1436.348	-1544.73	-940.991	661.75	-263.183	-821.34	707.726

APPENDIX B. Isotherm Data for North Inlet Sediments
1. Salt Water Isotherms

a. Oyster Landing

Sample	Initial P	Final P	P abs.	Initial P	Final P	P abs.
	µg-at L^{-1}	µg-at L^{-1}	µg-at P g^{-1} soil	µg L^{-1}	µg L-1	µg P g^{-1} soil
OL 0	0.243	2.62	-2.377	7.533	81.22	-73.687
	3.14	3.81	-0.67	97.34	118.11	-20.77
	6.75	4.03	2.72	209.25	124.93	84.32
	9.4	7.8	1.6	291.4	241.8	49.6
	12.8	6.65	6.15	396.8	206.15	190.65
	16.2	9.45	6.75	502.2	292.95	209.25
OL 2	0.525	10.5	-9.975	16.275	325.5	-309.225
	3.08	10.7	-7.62	95.48	331.7	-236.22
	6	11.55	-5.55	186	358.05	-172.05
	8.95	11.65	-2.7	277.45	361.15	-83.7
	12.45	13.4	-0.95	385.95	415.4	-29.45
	15.55	14.85	0.7	482.05	460.35	21.7
OL 4	0.525	11.85	-11.325	16.275	367.35	-351.075
	3.08	13.6	-10.52	95.48	421.6	-326.12
	6	15.6	-9.6	186	483.6	-297.6
	8.95	15.9	-6.95	277.45	492.9	-215.45
	12.45	12.85	-0.4	385.95	398.35	-12.4
	15.55	20.6	-5.05	482.05	638.6	-156.55

APPENDIX B. (cont.)

a. Oyster Landing

Sample	Initial P µg-at L^{-1}	Final P µg-at L^{-1}	P abs. µg-at P g^{-1} soil	Initial P µg L^{-1}	Final P µg L-1	P abs. µg P g^{-1} soil
OL 6	0.525	18.85	-18.325	16.275	584.35	-568.075
	3.08	16.4	-13.32	95.48	508.4	-412.92
	6	16.9	-10.9	186	523.9	-337.9
	8.95	17.95	-9	277.45	556.45	-279
	12.45	22.55	-10.1	385.95	699.05	-313.1
	15.55	21.05	-5.5	482.05	652.55	-170.5
OL 8	0.525	22.1	-21.575	16.275	685.1	-668.825
	3.08	5.6	-2.52	95.48	173.6	-78.12
	6	7.2	-1.2	186	223.2	-37.2
	8.95	8.3	0.65	277.45	257.3	20.15
	12.45	11.15	1.3	385.95	345.65	40.3
	15.55	13.15	2.4	482.05	407.65	74.4
OL 10	0.525	6.9	-6.375	16.275	213.9	-197.625
	3.08	8.05	-4.97	95.48	249.55	-154.07
	6	7.55	-1.55	186	234.05	-48.05
	8.95	10.5	-1.55	277.45	325.5	-48.05
	12.45	12.3	0.15	385.95	381.3	4.65
	15.55	14.85	0.7	482.05	460.35	21.7
OL 12	0.525	2.97	-2.445	16.275	92.07	-75.795
	3.08	6	-2.92	95.48	186	-90.52
	6	7.8	-1.8	186	241.8	-55.8
	8.95	9.25	-0.3	277.45	286.75	-9.3
	12.45	12.6	-0.15	385.95	390.6	-4.65
	15.55	16.02	-0.47	482.05	496.62	-14.57

APPENDIX B. (cont.)

a. Oyster Landing

Sample	Initial P µg-at L^{-1}	Final P µg-at L^{-1}	P abs. µg-at P g^{-1} soil	Initial P µg L^{-1}	Final P µg L-1	P abs. µg P g^{-1} soil
OL 14	0.525	3.05	-2.525	16.275	94.55	-78.275
	3.08	4.48	-1.4	95.48	138.88	-43.4
	6	6.5	-0.5	186	201.5	-15.5
	8.95	8.3	0.65	277.45	257.3	20.15
	12.45	10.6	1.85	385.95	328.6	57.35
	15.55	12.8	2.75	482.05	396.8	85.25
OL 16	0.525	3.61	-3.085	16.275	111.91	-95.635
	3.08	5.7	-2.62	95.48	176.7	-81.22
	6	6.7	-0.7	186	207.7	-21.7
	8.95	7.65	1.3	277.45	237.15	40.3
	12.45	10.45	2	385.95	323.95	62
	15.55	13.7	1.85	482.05	424.7	57.35
OL 18	0.525	5.15	-4.625	16.275	159.65	-143.375
	3.08	5.95	-2.87	95.48	184.45	-88.97
	6	7.3	-1.3	186	226.3	-40.3
	8.95	8.3	0.65	277.45	257.3	20.15
	12.45	11.65	0.8	385.95	361.15	24.8
	15.55	12.5	3.05	482.05	387.5	94.55

APPENDIX B. (cont.)

a. Oyster Landing

Sample	Initial P µg-at L⁻¹	Final P µg-at L⁻¹	P abs. µg-at P g⁻¹ soil	Initial P µg L⁻¹	Final P µg L-1	P abs. µg P g⁻¹ soil
OL 20	0.835	5.2	-4.365	25.885	161.2	-135.315
	2.98	2.85	0.13	92.38	88.35	4.03
	6.75	6.45	0.3	209.25	199.95	9.3
	8.6	6.8	1.8	266.6	210.8	55.8
	11.6	5.55	6.05	359.6	172.05	187.55
	14.7	8.85	5.85	455.7	274.35	181.35
OL 22	0.835	2.55	-1.715	25.885	79.05	-53.165
	2.98	1.84	1.14	92.38	57.04	35.34
	6.75	3.53	3.22	209.25	109.43	99.82
	8.6	2.96	5.64	266.6	91.76	174.84
	11.6	3.59	8.01	359.6	111.29	248.31
	14.7	2.66	12.04	455.7	82.46	373.24
OL 24	0.835	2.14	-1.305	25.885	66.34	-40.455
	2.98	2.4	0.58	92.38	74.4	17.98
	6.75	2.58	4.17	209.25	79.98	129.27
	8.6	2.84	5.76	266.6	88.04	178.56
	11.6	3.55	8.05	359.6	110.05	249.55
	14.7	6.55	8.15	455.7	203.05	252.65

APPENDIX B. (cont.)

b. Town Creek

Sample	Initial P µg-at L^{-1}	Final P µg-at L^{-1}	P abs. µg-at P g^{-1} soil	Initial P µg L^{-1}	Final P µg L-1	P abs. µg P g^{-1} soil
TC 10	0.243	6.25	-6.007	7.533	193.75	-186.217
	3.39	11.25	-7.86	105.09	348.75	-243.66
	6.75	10.35	-3.6	209.25	320.85	-111.6
	8.65	13.5	-4.85	268.15	418.5	-150.35
	12.55	20.6	-8.05	389.05	638.6	-249.55
	16.15	16.5	-0.35	500.65	511.5	-10.85
TC 20	0.186	4.88	-4.694	5.766	151.28	-145.514
	3.39	7.55	-4.16	105.09	234.05	-128.96
	6.5	7.6	-1.1	201.5	235.6	-34.1
	8.65	9.35	-0.7	268.15	289.85	-21.7
	12.55	10.4	2.15	389.05	322.4	66.65
	16.15	11.3	4.85	500.65	350.3	150.35
TC 30	0.186	4.39	-4.204	5.766	136.09	-130.324
	3.39	5.3	-1.91	105.09	164.3	-59.21
	6.5	6.8	-0.3	201.5	210.8	-9.3
	8.65	6.9	1.75	268.15	213.9	54.25
	12.55	9.75	2.8	389.05	302.25	86.8
	16.15	11.45	4.7	500.65	354.95	145.7

APPENDIX B. (cont.)

b. Town Creek

Sample	Initial P μg-at L^{-1}	Final P μg-at L^{-1}	P abs. μg-at P g^{-1} soil	Initial P μg L^{-1}	Final P μg L-1	P abs. μg P g^{-1} soil
TC 40	0.186	4.71	-4.524	5.766	146.01	-140.244
	3.39	4.67	-1.28	105.09	144.77	-39.68
	6.5	7	-0.5	201.5	217	-15.5
	8.65	8.55	0.1	268.15	265.05	3.1
	12.55	10.95	1.6	389.05	339.45	49.6
	16.15	12.5	3.65	500.65	387.5	113.15
TC 50	0.186	4.105	-3.919	5.766	127.255	-121.489
	3.39	4.41	-1.02	105.09	136.71	-31.62
	6.5	7	-0.5	201.5	217	-15.5
	8.65	8.15	0.5	268.15	252.65	15.5
	12.55	10.3	2.25	389.05	319.3	69.75
	16.15	9.25	6.9	500.65	286.75	213.9
TC 60	0.186	2.55	-2.364	5.766	79.05	-73.284
	3.39	3.77	-0.38	105.09	116.87	-11.78
	6.5	5.75	0.75	201.5	178.25	23.25
	8.65	7.6	1.05	268.15	235.6	32.55
	12.55	4.05	8.5	389.05	125.55	263.5
	16.15	10	6.15	500.65	310	190.65
TC 70	0.424	5.75	-5.326	13.144	178.25	-165.106
	4.24	9	-4.76	131.44	279	-147.56
	6.5	9.9	-3.4	201.5	306.9	-105.4
	9.25	10.7	-1.45	286.75	331.7	-44.95
	12.7	13.3	-0.6	393.7	412.3	-18.6
	16.3	14.55	1.75	505.3	451.05	54.25

APPENDIX B. (cont.)

b. Town Creek

Sample	Initial P	Final P	P abs.	Initial P	Final P	P abs.
	μg-at L^{-1}	μg-at L^{-1}	μg-at P g^{-1} soil	μg L^{-1}	μg L-1	μg P g^{-1} soil
TC 80	0.424	4.815	-4.391	13.144	149.265	-136.121
	4.24	7.9	-3.66	131.44	244.9	-113.46
	6.5	9.5	-3	201.5	294.5	-93
	9.25	11.75	-2.5	286.75	364.25	-77.5
	12.7	14.4	-1.7	393.7	446.4	-52.7
	16.3	15.85	0.45	505.3	491.35	13.95
TC 90	0.424	7.25	-6.826	13.144	224.75	-211.606
	4.24	6.7	-2.46	131.44	207.7	-76.26
	6.5	9.05	-2.55	201.5	280.55	-79.05
	9.25	11.1	-1.85	286.75	344.1	-57.35
	12.7	16.6	-3.9	393.7	514.6	-120.9
	16.3	15.7	0.6	505.3	486.7	18.6
TC 100	0.424	8.8	-8.376	13.144	272.8	-259.656
	4.24	8.6	-4.36	131.44	266.6	-135.16
	6.5	10.3	-3.8	201.5	319.3	-117.8
	9.25	12.4	-3.15	286.75	384.4	-97.65
	12.7	15.3	-2.6	393.7	474.3	-80.6
	16.3	21.25	-4.95	505.3	658.75	-153.45

APPENDIX B. (cont.)

c. No Man's Friend

Sample	Initial P	Final P	P abs.	Initial P	Final P	P abs.
	μg-at L^{-1}	μg-at L^{-1}	μg-at P g^{-1} soil	μg L^{-1}	μg L-1	μg P g^{-1} soil
NMF 0	0.243	1.28	-1.037	7.533	39.68	-32.147
	3.14	1.71	1.43	97.34	53.01	44.33
	6.75	1.67	5.08	209.25	51.77	157.48
	9.4	1.77	7.63	291.4	54.87	236.53
	12.8	1.87	10.93	396.8	57.97	338.83
	16.2	1.97	14.23	502.2	61.07	441.13
NMF 10	0.835	0.916	-0.081	25.885	28.396	-2.511
	2.98	0.893	2.087	92.38	27.683	64.697
	5.65	0.948	4.702	175.15	29.388	145.762
	8.6	0.954	7.646	266.6	29.574	237.026
	11.6	0.775	10.825	359.6	24.025	335.575
	14.7	0.76	13.94	455.7	23.56	432.14
NMF 20	0.243	1.59	-1.347	7.533	49.29	-41.757
	3.14	1.86	1.28	97.34	57.66	39.68
	6.75	1.84	4.91	209.25	57.04	152.21
	9.4	1.91	7.49	291.4	59.21	232.19
	12.8	1.98	10.82	396.8	61.38	335.42
	16.2	2.14	14.06	502.2	66.34	435.86

APPENDIX B. (cont.)

c. No Man's Friend

Sample	Initial P	Final P	P abs.	Initial P	Final P	P abs.
	μg-at L^{-1}	μg-at L^{-1}	μg-at P g^{-1} soil	μg L^{-1}	μg L-1	μg P g^{-1} soil
NMF 30	0.835	1.66	-0.825	25.885	51.46	-25.575
	2.98	1.75	1.23	92.38	54.25	38.13
	5.65	1.81	3.84	175.15	56.11	119.04
	8.6	2.03	6.57	266.6	62.93	203.67
	11.6	1.72	9.88	359.6	53.32	306.28
	14.7	1.93	12.77	455.7	59.83	395.87
NMF 40	0.186	0.555	-0.369	5.766	17.205	-11.439
	3.39	0.533	2.857	105.09	16.523	88.567
	6.5	0.57	5.93	201.5	17.67	183.83
	8.65	0.671	7.979	268.15	20.801	247.349
	12.55	0.64	11.91	389.05	19.84	369.21
	16.15	0.787	15.363	500.65	24.397	476.253
NMF 50	0.186	0.474	-0.288	5.766	14.694	-8.928
	3.39	0.304	3.086	105.09	9.424	95.666
	6.5	0.287	6.213	201.5	8.897	192.603
	8.65	0.274	8.376	268.15	8.494	259.656
	12.55	0.316	12.234	389.05	9.796	379.254
	16.15	0.306	15.844	500.65	9.486	491.164
NMF 80	0.186	0.94	-0.754	5.766	29.14	-23.374
	3.39	0.623	2.767	105.09	19.313	85.777
	6.5	1.29	5.21	201.5	39.99	161.51
	8.65	1.17	7.48	268.15	36.27	231.88
	12.55	1.15	11.4	389.05	35.65	353.4
	16.15	1.31	14.84	500.65	40.61	460.04

APPENDIX B. Isotherm Data for North Inlet Sediments

1. Brackish Water Isotherms

a. Oyster Landing

Sample	Initial P	Final P	P abs.	Initial P	Final P	P abs.
	μg-at L^{-1}	μg-at L^{-1}	μg-at P g^{-1} soil	μg L^{-1}	μg L-1	μg P g^{-1} soil
YM 0	0.775	0.554	0.221	24.025	17.174	6.851
	2.93	0.253	2.677	90.83	7.843	82.987
	7.8	0.141	7.659	241.8	4.371	237.429
	9.84	3.02	6.82	305.04	93.62	211.42
	12.96	2.21	10.75	401.76	68.51	333.25
	16.16	4.21	11.95	500.96	130.51	370.45
YM 2	0.775	1.31	-0.535	24.025	40.61	-16.585
	2.93	1.09	1.84	90.83	33.79	57.04
	7.8	2.18	5.62	241.8	67.58	174.22
	9.84	1.43	8.41	305.04	44.33	260.71
	12.96	1.57	11.39	401.76	48.67	353.09
	16.16	4.04	12.12	500.96	125.24	375.72
YM 4	0.775	0.748	0.027	24.025	23.188	0.837
	2.93	1.62	1.31	90.83	50.22	40.61
	7.8	3.33	4.47	241.8	103.23	138.57
	9.84	7.04	2.8	305.04	218.24	86.8
	12.96	6.54	6.42	401.76	202.74	199.02
	16.16	11.72	4.44	500.96	363.32	137.64

APPENDIX B. (cont.)

a. Oyster Landing

Sample	Initial P	Final P	P abs.	Initial P	Final P	P abs.
	μg-at L^{-1}	μg-at L^{-1}	μg-at P g^{-1} soil	μg L^{-1}	μg L-1	μg P g^{-1} soil
YM 6	0.775	1.78	-1.005	24.025	55.18	-31.155
	2.93	2.49	0.44	90.83	77.19	13.64
	7.8	4.05	3.75	241.8	125.55	116.25
	9.84	6	3.84	305.04	186	119.04
	12.96	7.52	5.44	401.76	233.12	168.64
	16.16	10.68	5.48	500.96	331.08	169.88
YM 8	0.775	0.67	0.105	24.025	20.77	3.255
	2.93	1.47	1.46	90.83	45.57	45.26
	7.8	1.77	6.03	241.8	54.87	186.93
	9.84	3.01	6.83	305.04	93.31	211.73
	12.96	3.33	9.63	401.76	103.23	298.53
	16.16	5.96	10.2	500.96	184.76	316.2
YM 10	0.775	1.23	-0.455	24.025	38.13	-14.105
	2.93	1.99	0.94	90.83	61.69	29.14
	7.8	3.92	3.88	241.8	121.52	120.28
	9.84	5.62	4.22	305.04	174.22	130.82
	12.96	6.64	6.32	401.76	205.84	195.92
	16.16	6.26	9.9	500.96	194.06	306.9
YM 12	0.775	0.816	-0.041	24.025	25.296	-1.271
	2.93	1.19	1.74	90.83	36.89	53.94
	7.8	2.04	5.76	241.8	63.24	178.56
	9.84	3.3	6.54	305.04	102.3	202.74
	12.96	5.8	7.16	401.76	179.8	221.96
	16.16	8.62	7.54	500.96	267.22	233.74

APPENDIX B. (cont.)

a. Oyster Landing

Sample	Initial P µg-at L^{-1}	Final P µg-at L^{-1}	P abs. µg-at P g^{-1} soil	Initial P µg L^{-1}	Final P µg L-1	P abs. µg P g^{-1} soil
YM 14	0.775	0.857	-0.082	24.025	26.567	-2.542
	2.93	1.43	1.5	90.83	44.33	46.5
	7.8	2.52	5.28	241.8	78.12	163.68
	9.84	3.84	6	305.04	119.04	186
	12.96	6.18	6.78	401.76	191.58	210.18
	16.16	7.42	8.74	500.96	230.02	270.94
YM 16	0.775	0.211	0.564	24.025	6.541	17.484
	2.93	0.754	2.176	90.83	23.374	67.456
	7.8	1.07	6.73	241.8	33.17	208.63
	9.84	0.29	9.55	305.04	8.99	296.05
	12.96	0.959	12.001	401.76	29.729	372.031
	16.16	3.43	12.73	500.96	106.33	394.63
YM 18	0.775	0.582	0.193	24.025	18.042	5.983
	2.93	0.684	2.246	90.83	21.204	69.626
	7.8	0.479	7.321	241.8	14.849	226.951
	9.84	0.905	8.935	305.04	28.055	276.985
	12.96	0.886	12.074	401.76	27.466	374.294
	16.16	1.06	15.1	500.96	32.86	468.1
YM 20	0.775	0.793	-0.018	24.025	24.583	-0.558
	2.93	0.675	2.255	90.83	20.925	69.905
	7.8	0.708	7.092	241.8	21.948	219.852
	9.84	1.76	8.08	305.04	54.56	250.48
	12.96	0.695	12.265	401.76	21.545	380.215
	16.16	0.865	15.295	500.96	26.815	474.145

APPENDIX B. (cont.)

b. Town Creek

Sample	Initial P	Final P	P abs.	Initial P	Final P	P abs.
	µg-at L^{-1}	µg-at L^{-1}	µg-at P g^{-1} soil	µg L^{-1}	µg L-1	µg P g^{-1} soil
TO 10	0.024	3.16	-3.136	0.744	97.96	-97.216
	2.57	1.89	0.68	79.67	58.59	21.08
	6.52	2.8	3.72	202.12	86.8	115.32
	9	3.46	5.54	279	107.26	171.74
	12.64	3.75	8.89	391.84	116.25	275.59
	16.04	8.14	7.9	497.24	252.34	244.9
TO 20	0.024	4.01	-3.986	0.744	124.31	-123.566
	2.57	4.1	-1.53	79.67	127.1	-47.43
	6.52	6.64	-0.12	202.12	205.84	-3.72
	9	7.26	1.74	279	225.06	53.94
	12.64	9.44	3.2	391.84	292.64	99.2
	16.04	11.58	4.46	497.24	358.98	138.26
TO 30	0.024	2.21	-2.186	0.744	68.51	-67.766
	2.57	3.38	-0.81	79.67	104.78	-25.11
	6.52	4.42	2.1	202.12	137.02	65.1
	9	8.26	0.74	279	256.06	22.94
	12.64	10.92	1.72	391.84	338.52	53.32
	16.04	11.5	4.54	497.24	356.5	140.74

APPENDIX B. (cont.)

b. Town Creek

Sample	Initial P	Final P	P abs.	Initial P	Final P	P abs.
	μg-at L^{-1}	μg-at L^{-1}	μg-at P g^{-1} soil	μg L^{-1}	μg L-1	μg P g^{-1} soil
TO 40	0.024	2.75	-2.726	0.744	85.25	-84.506
	2.57	3.28	-0.71	79.67	101.68	-22.01
	6.52	4.52	2	202.12	140.12	62
	9	7.06	1.94	279	218.86	60.14
	12.64	9.06	3.58	391.84	280.86	110.98
	16.04	11.1	4.94	497.24	344.1	153.14
TO 50	0.024	2.54	-2.516	0.744	78.74	-77.996
	2.57	3.22	-0.65	79.67	99.82	-20.15
	6.52	4.55	1.97	202.12	141.05	61.07
	9	5.5	3.5	279	170.5	108.5
	12.64	8.92	3.72	391.84	276.52	115.32
	16.04	11.36	4.68	497.24	352.16	145.08
TO 60	0.024	2.64	-2.616	0.744	81.84	-81.096
	2.57	2.45	0.12	79.67	75.95	3.72
	6.52	4.27	2.25	202.12	132.37	69.75
	9	6.54	2.46	279	202.74	76.26
	12.64	8.84	3.8	391.84	274.04	117.8
	16.04	8.76	7.28	497.24	271.56	225.68
TO 70	0.024	1.78	-1.756	0.744	55.18	-54.436
	2.57	2.68	-0.11	79.67	83.08	-3.41
	6.52	4.04	2.48	202.12	125.24	76.88
	9	5.98	3.02	279	185.38	93.62
	12.64	8.46	4.18	391.84	262.26	129.58
	16.04	9.56	6.48	497.24	296.36	200.88

APPENDIX B. (cont.)

b. Town Creek

Sample	Initial P	Final P	P abs.	Initial P	Final P	P abs.
	μg-at L^{-1}	μg-at L^{-1}	μg-at P g^{-1} soil	μg L^{-1}	μg L-1	μg P g^{-1} soil
TO 80	0.024	1.7	-1.676	0.744	52.7	-51.956
	2.57	2.74	-0.17	79.67	84.94	-5.27
	6.52	4.33	2.19	202.12	134.23	67.89
	9	5.88	3.12	279	182.28	96.72
	12.64	7.06	5.58	391.84	218.86	172.98
	16.04	8.64	7.4	497.24	267.84	229.4
TO 90	0.024	1.5	-1.476	0.744	46.5	-45.756
	2.57	2.11	0.46	79.67	65.41	14.26
	6.52	3.16	3.36	202.12	97.96	104.16
	9	5.42	3.58	279	168.02	110.98
	12.64	5.94	6.7	391.84	184.14	207.7
	16.04	7.96	8.08	497.24	246.76	250.48
TO 100	0.024	1.51	-1.486	0.744	46.81	-46.066
	2.57	2.57	0	79.67	79.67	0
	6.52	4.1	2.42	202.12	127.1	75.02
	9	5.72	3.28	279	177.32	101.68
	12.64	6.8	5.84	391.84	210.8	181.04
	16.04	8.7	7.34	497.24	269.7	227.54

APPENDIX B. (cont.)

c. No Man's Friend

Sample	Initial P	Final P	P abs.	Initial P	Final P	P abs.
	μg-at L^{-1}	μg-at L^{-1}	μg-at P g^{-1} soil	μg L^{-1}	μg L-1	μg P g^{-1} soil
NM 30	0.024	0.91	-0.886	0.744	28.21	-27.466
	2.57	0.677	1.893	79.67	20.987	58.683
	6.52	0.765	5.755	202.12	23.715	178.405
	9	0.987	8.013	279	30.597	248.403
	12.64	0.934	11.706	391.84	28.954	362.886
	16.04	0.809	15.231	497.24	25.079	472.161
NM40	0.024	0.549	-0.525	0.744	17.019	-16.275
	2.57	0.571	1.999	79.67	17.701	61.969
	6.52	0.772	5.748	202.12	23.932	178.188
	9	0.958	8.042	279	29.698	249.302
	12.64	1.08	11.56	391.84	33.48	358.36
	16.04	1.53	14.51	497.24	47.43	449.81
NM 60	0.024	0.271	-0.247	0.744	8.401	-7.657
	2.57	0.374	2.196	79.67	11.594	68.076
	6.52	0.588	5.932	202.12	18.228	183.892
	9	0.458	8.542	279	14.198	264.802
	12.64	0.346	12.294	391.84	10.726	381.114
	16.04	0.357	15.683	497.24	11.067	486.173

APPENDIX B. (cont.)

c. No Man's Friend

Sample	Initial P	Final P	P abs.	Initial P	Final P	P abs.
	μg-at L^{-1}	μg-at L^{-1}	μg-at P g^{-1} soil	μg L^{-1}	μg L-1	μg P g^{-1} soil
NM 70	0.024	0.792	-0.768	0.744	24.552	-23.808
	2.57	0.59	1.98	79.67	18.29	61.38
	6.52	0.602	5.918	202.12	18.662	183.458
	9	1.27	7.73	279	39.37	239.63
	12.64		12.64	391.84	0	391.84
	16.04	0.558	15.482	497.24	17.298	479.942
NM 80	0.024	1.09	-1.066	0.744	33.79	-33.046
	2.57	0.345	2.225	79.67	10.695	68.975
	6.52	0.403	6.117	202.12	12.493	189.627
	9	0.591	8.409	279	18.321	260.679
	12.64	0.291	12.349	391.84	9.021	382.819
	16.04	0.662	15.378	497.24	20.522	476.718
NM 90	0.024	0.571	-0.547	0.744	17.701	-16.957
	2.57	0.701	1.869	79.67	21.731	57.939
	6.52	0.611	5.909	202.12	18.941	183.179
	9	0.695	8.305	279	21.545	257.455
	12.64	1.17	11.47	391.84	36.27	355.57
	16.04	1.74	14.3	497.24	53.94	443.3

APPENDIX C. Nutrient Data from benthic chambers. 1991.

1. Oyster Landing

a. Marsh Site, C-1.

		Conc. (µg-at l^{-1})				Mass (µg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.7	0.195	3.35	14.1	0.5103	0.142155	2.44215	10.2789	7:21
10	0.729	0.726	0.232	3.28	13.4	0.529254	0.169128	2.39112	9.7686	9:30
10	0.729	0.481	0.0612	0.254	11.7	0.350649	0.044615	0.185166	8.5293	17:50
10	0.729	0.406	0.0718		11.7	0.295974	0.052342	0	8.5293	19:30
20	0.729	0.619	0.161	3.9	13	0.451251	0.117369	2.8431	9.477	7:21
20	0.729	0.683	0.212	2.71	13.6	0.497907	0.154548	1.97559	9.9144	9:30
20	0.729	0.546	0.104	0.301	11.1	0.398034	0.075816	0.219429	8.0919	17:50
20	0.729	0.377	0.0651		11.6	0.274833	0.047458	0	8.4564	19:30
30	0.729	1.05	0.23	3.75	15	0.76545	0.16767	2.73375	10.935	7:21
30	0.729	0.703	0.205	3.03	13.3	0.512487	0.149445	2.20887	9.6957	9:30
30	0.729	0.568	0.119	0.291	11.4	0.414072	0.086751	0.212139	8.3106	17:50
30	0.729	0.363	0.0704		11.6	0.264627	0.051322	0	8.4564	19:30
40	1.458	0.989	0.244	3.87	15.5	1.441962	0.355752	5.64246	22.599	7:21
40	1.458	0.182	0.697	1.85	14.1	0.265356	1.016226	2.6973	20.5578	9:30
40	1.458	0.588	0.18	1.12	9.5	0.857304	0.26244	1.63296	13.851	17:50
40	1.458	0.385	0.0683	1.84	11.2	0.56133	0.099581	2.68272	16.3296	19:30
60	1.458	0.674	0.169	3.25	14.6	0.982692	0.246402	4.7385	21.2868	7:21
60	1.458	0.368	0.0855	1.06	9.9	0.536544	0.124659	1.54548	14.4342	19:30
80	1.458	0.37	0.0849	0.691	9	0.53946	0.123784	1.007478	13.122	19:30
100	1.458	0.722	1.14	5.26	9.5	1.052676	1.66212	7.66908	13.851	19:30
				Flux:	Ebb	4.368	-2.134	12.989	21.183	
					Flood	9.065	9.721	55.538	236.605	

APPENDIX C. (cont.)

1. Oyster Landing

b. Marsh Site, C-2.

		Conc. (μg-at l^{-1})				Mass (μg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	1.02	0.326	7.12	13.7	0.74358	0.237654	5.19048	9.9873	7:21
10	0.729	0.995	0.352	6.47	12.7	0.725355	0.256608	4.71663	9.2583	9:30
10	0.729	0.764	0.191	2.99	11.5	0.556956	0.139239	2.17971	8.3835	17:50
10	0.729	0.694	0.229	3.15	14.3	0.505926	0.166941	2.29635	10.4247	19:30
20	0.729	1.21	0.382	7.06	14.6	0.88209	0.278478	5.14674	10.6434	7:21
20	0.729	0.923	0.383	6.41	12.6	0.672867	0.279207	4.67289	9.1854	9:30
20	0.729	0.898	0.204	4.11	11.9	0.654642	0.148716	2.99619	8.6751	17:50
20	0.729	0.711	0.192	4.09	12	0.518319	0.139968	2.98161	8.748	19:30
30	0.729	0.966	0.365	6.85	14.6	0.704214	0.266085	4.99365	10.6434	7:21
30	0.729	0.868	0.236	5.33	10.7	0.632772	0.172044	3.88557	7.8003	9:30
30	0.729	1.43	0.234		11.6	1.04247	0.170586	0	8.4564	17:50
30	0.729	0.686	0.205	4.5	10.3	0.500094	0.149445	3.2805	7.5087	19:30
40	1.458	0.931	0.355	10.1	15.9	1.357398	0.51759	14.7258	23.1822	7:21
40	1.458	0.998	0.39	7.32	13.4	1.455084	0.56862	10.67256	19.5372	9:30
40	1.458	1.13	0.2	6.34	10.8	1.64754	0.2916	9.24372	15.7464	17:50
40	1.458	0.918	0.234	7.36	12.1	1.338444	0.341172	10.73088	17.6418	19:30
60	1.458	0.908	0.302	6.9	15.8	1.323864	0.440316	10.0602	23.0364	7:21
60	1.458	0.943	0.256	7.89	11.3	1.374894	0.373248	11.50362	16.4754	19:30
80	1.458	0.973	0.267	8.04	11.2	1.418634	0.389286	11.72232	16.3296	19:30
100	1.458	0.904	0.308	8.57	11.6	1.318032	0.449064	12.49506	16.9128	19:30
				Flux	Ebb	4.668	2.446	20.423	115.505	
					Flood	6.551	8.025	22.154	183.049	

APPENDIX C. (cont.)

1. Oyster Landing

c. Bank Site, C-3.

		Conc. (µg-at l^{-1})				Mass (µg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	1.62	0.258	4.86	12.8	1.18098	0.188082	3.54294	9.3312	7:39
10	0.729	0.313	0.264	1.56	10.9	0.228177	0.192456	1.13724	7.9461	9:40
10	0.729	0.324	0.221	2.71	11.2	0.236196	0.161109	1.97559	8.1648	11:30
10	0.729	0.278	0.0998	1.55	12.5	0.202662	0.072754	1.12995	9.1125	17:40
10	0.729	0.343	0.108	0.899	10	0.250047	0.078732	0.655371	7.29	19:30
20	0.729	0.397	0.188	4.03	13.2	0.289413	0.137052	2.93787	9.6228	7:39
20	0.729	0.311	0.211	1.29	10.3	0.226719	0.153819	0.94041	7.5087	9:40
20	0.729	0.338	0.216	1.55	9.3	0.246402	0.157464	1.12995	6.7797	11:30
20	0.729	0.403	0.134		11.3	0.293787	0.097686	0	8.2377	17:40
20	0.729	0.311	0.111	1.17	9.8	0.226719	0.080919	0.85293	7.1442	19:30
40	1.458	0.384	0.178	1.02	13	0.559872	0.259524	1.48716	18.954	7:39
40	1.458	0.417	0.158	1.56	10.8	0.607986	0.230364	2.27448	15.7464	9:40
40	1.458	0.381	0.11	2.73	11.8	0.555498	0.16038	3.98034	17.2044	11:30
40	1.458	0.298	0.108	0.929	9.7	0.434484	0.157464	1.354482	14.1426	17:40
60	1.458	0.52	0.322	1.9	9.8	0.75816	0.469476	2.7702	14.2884	19:30
60	1.458	0.395	0.182	1.2	10.1	0.57591	0.265356	1.7496	14.7258	7:39
60	1.458	0.382	0.129	2.17	9.8	0.57591	0.188082	3.16386	14.2884	9:40
60	1.458	0.31	0.0986	1.36	9.8	0.556956	0.143759	1.98288	14.2884	11:30
80	1.458	0.418	0.215	3.61	12.1	0.45198	0.31347	5.26338	17.6418	17:40
80	1.458	0.554	0.133	1.21	10.3	0.609444	0.193914	1.76418	15.0174	19:30
80	1.458	0.439	0.0942	2.89	10.8	0.807732	0.137344	4.21362	15.7464	7:39

cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
80	1.458	0.318	0.116	0.927	9.9	0.640062	0.169128	1.351566	14.4342	9:40
100	1.458	0.323	0.205	1.14	11.2	0.463644	0.29889	1.66212	16.3296	11:30
100	1.458	0.352	0.145	0.826	9.8	0.470934	0.21141	1.204308	14.2884	17:40
120	1.458	0.391	0.364	2.91	10	0.513216	0.530712	4.24278	14.58	19:30
140	1.458	0.366	0.513	3.35	8.1	0.570078	0.747954	4.8843	11.8098	19:30
				Flux	Ebb	4.668	2.446	20.423	115.505	
					Flood	6.551	8.025	22.154	183.049	

1. Oyster Landing

d. Bank Site, C-4.

		Conc. (µg-at l^{-1})				Mass (µg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.426	0.246	2.38	7.2	0.310554	0.179334	1.73502	5.2488	7:39
10	0.729	0.521	0.155	0.854	6.7	0.379809	0.112995	0.622566	4.8843	9:40
10	0.729	0.54	0.243	1.35	4.5	0.39366	0.177147	0.98415	3.2805	11:30
10	0.729	0.572	0.0596	0.778	7.6	0.416988	0.043448	0.567162	5.5404	17:40
10	0.729	0.624	0.358	0.13	6.4	0.454896	0.260982	0.09477	4.6656	19:30
20	0.729	0.399	0.185	1.93	6.4	0.290871	0.134865	1.40697	4.6656	7:39
20	0.729	0.46	0.137	1.49	6.6	0.33534	0.099873	1.08621	4.8114	9:40
20	0.729	0.641	0.191	2.1	4.6	0.467289	0.139239	1.5309	3.3534	11:30
20	0.729	0.557	0.0804	0.532	6.8	0.406053	0.058612	0.387828	4.9572	17:40
20	0.729	0.509	0.09	0.343	5.2	0.371061	0.06561	0.250047	3.7908	19:30
40	1.458	0.454	0.251	4.54	7.3	0.661932	0.365958	6.61932	10.6434	7:39
40	1.458	0.564	0.133	1.42	5.6	0.822312	0.193914	2.07036	8.1648	9:40
40	1.458	0.573	0.104	0.553	7.3	0.835434	0.151632	0.806274	10.6434	11:30
40	1.458	0.483	0.0809	0.186	5.3	0.704214	0.117952	0.271188	7.7274	17:40

60	1.458	0.375	0.188	1.76	7.6	0.54675	0.274104	2.56608	11.0808	19:30
60	1.458	0.434	0.18	3.81	6.5	0.632772	0.26244	5.55498	9.477	7:39
60	1.458	0.619	0.149	0.33	7.4	0.632772	0.217242	0.48114	10.7892	9:40
60	1.458	0.537	0.1	0.334	5.6	0.902502	0.1458	0.486972	8.1648	11:30
80	1.458	0.428	0.228	1.76	5.8	0.782946	0.332424	2.56608	8.4564	17:40
80	1.458	0.576	0.205	1.79	6.8	0.624024	0.29889	2.60982	9.9144	19:30
80	1.458	0.537	0.101	0.593	6.5	0.839808	0.147258	0.864594	9.477	7:39
80	1.458	0.53	0.118	0.226	5.3	0.782946	0.172044	0.329508	7.7274	9:40
100	1.458	0.861	0.337	3.27	9.6	0.77274	0.491346	4.76766	13.9968	11:30
100	1.458	0.554	0.136	0.264	5.3	1.255338	0.198288	0.384912	7.7274	17:40
120	1.458	0.557	0.236	0.941	6	0.807732	0.344088	1.371978	8.748	19:30
				Flux	Ebb	.312	2.622	25.603	55.956	
					Flood	7.466	3.746	.452	39.168	

1. Oyster Landing

e. Bank Site, C-5.

		Conc. (μg-at l^{-1})				Mass (μg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.583	0.17	0.884	7.4	0.425007	0.12393	0.644436	5.3946	7:50
10	0.729	0.888	0.171	1.99	5.7	0.647352	0.124659	1.45071	4.1553	9:55
10	0.729	0.304	0.163	0.835	5.8	0.221616	0.118827	0.608715	4.2282	11:35
10	0.729	0.616	3.44		15.2	0.449064	2.50776	0	11.0808	13:30
10	0.729	0.271	0.142	0.977	6.5	0.197559	0.103518	0.712233	4.7385	15:25
10	0.729	0.345	0.0975	0.123	3.5	0.251505	0.071078	0.089667	2.5515	17:30
10	0.729	0.553	0.113	1.5	3.4	0.403137	0.082377	1.0935	2.4786	19:30
20	0.729	0.607	0.135	1.08	8.1	0.442503	0.098415	0.78732	5.9049	7:50
20	0.729	0.39	0.166	0.832	5.2	0.28431	0.121014	0.606528	3.7908	9:55

20	0.729	0.392	0.154	1.12	5.8	0.285768	0.112266	0.81648	4.2282	11:35
20	0.729	0.416	0.105	0.94	4.2	0.303264	0.076545	0.68526	3.0618	15:25
20	0.729	0.331	0.0872	0.62	3.5	0.241299	0.063569	0.45198	2.5515	17:30
20	0.729	0.544	0.11	1.05	3.4	0.396576	0.08019	0.76545	2.4786	19:30
40	1.458	0.573	0.171	0.781	7.3	0.835434	0.249318	1.138698	10.6434	7:50
40	1.458	0.435	0.156	0.713	4.8	0.63423	0.227448	1.039554	6.9984	9:55
40	1.458	0.431	0.122	0.983	5.7	0.628398	0.177876	1.433214	8.3106	11:35
40	1.458	0.504	0.227	1.45	4.5	0.734832	0.330966	2.1141	6.561	15:25
40	1.458	0.336	0.0904	1.27	3.3	0.489888	0.131803	1.85166	4.8114	17:30
40	1.458	0.606	0.106	1.23	2.8	0.883548	0.154548	1.79334	4.0824	19:30
60	1.458	0.472	0.137	0.497	6.5	0.688176	0.199746	0.724626	9.477	7:50
60	1.458	0.391	0.172	0.689	4.6	0.570078	0.250776	1.004562	6.7068	9:55
60	1.458	0.339	0.101	1.6	3.4	0.494262	0.147258	2.3328	4.9572	17:30
60	1.458	0.512	0.105	1.51	3.5	0.746496	0.15309	2.20158	5.103	19:30
80	1.458	0.467	0.154	0.656	7.5	0.680886	0.224532	0.956448	10.935	7:50
80	1.458	1.01	0.174	0.739	4.8	1.47258	0.253692	1.077462	6.9984	9:55
80	1.458	0.398	0.0984	1.2	3.4	0.580284	0.143467	1.7496	4.9572	17:30
80	1.458	0.534	0.117	0.978	2.8	0.778572	0.170586	1.425924	4.0824	19:30
100	1.458	0.457	0.127	0.519	6.5	0.666306	0.185166	0.756702	9.477	7:50
100	1.458	0.416	0.146	0.597	4.5	0.606528	0.212868	0.870426	6.561	9:55
100	1.458	0.441	0.136	0.726	6.9	0.642978	0.198288	1.058508	10.0602	17:30
100	1.458	0.515	0.103	0.883	2.9	0.75087	0.150174	1.287414	4.2282	19:30
120	1.458	0.484	0.154	0.688	6.5	0.705672	0.224532	1.003104	9.477	7:50
120	1.458	0.454	2.82	2.46	6.3	0.661932	4.11156	3.58668	9.1854	19:30
140	1.458	0.446	0.122	0.509	6.9	0.650268	0.177876	0.742122	10.0602	7:50
				Flux	**Ebb**	1.639	-13.437	-7.366	45.163	
					Flood	22.873	13.129	66.633	112.707	

APPENDIX C. (cont.)

1. Oyster Landing

f. Bank Site, C-6.

		Conc. (μg-at l^{-1})				Mass (μg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.543	0.189	1.21	6.7	0.395847	0.137781	0.88209	4.8843	7:50
10	0.729	0.382	0.184	0.552	4.3	0.278478	0.134136	0.402408	3.1347	9:55
10	0.729	0.236	0.112		4.8	0.172044	0.081648	0	3.4992	11:35
10	0.729	0.696	3.6	6.24	16.3	0.507384	2.6244	4.54896	11.8827	13:30
10	0.729	0.536	0.128	2.21	5.2	0.390744	0.093312	1.61109	3.7908	15:25
10	0.729	1.09	0.0905	0.418	3.9	0.79461	0.065975	0.304722	2.8431	17:30
10	0.729	0.546	0.113	1.13	3.1	0.398034	0.082377	0.82377	2.2599	19:30
20	0.729	0.909	0.183	1.27	6.6	0.662661	0.133407	0.92583	4.8114	7:50
20	0.729	0.493	0.239	0.998	4.7	0.359397	0.174231	0.727542	3.4263	9:55
20	0.729	0.0146	0.108		4.9	0.010643	0.078732	0	3.5721	11:35
20	0.729	0.545	0.124	2.66	3.9	0.397305	0.090396	1.93914	2.8431	15:25
20	0.729	1.1	0.13	0.695	3.9	0.8019	0.09477	0.506655	2.8431	17:30
20	0.729	0.555	0.104	1.32	3.2	0.404595	0.075816	0.96228	2.3328	19:30
40	1.458	0.478	0.156	1.01	6.7	0.696924	0.227448	1.47258	9.7686	7:50
40	1.458	0.847	0.194	1.23	4.6	1.234926	0.282852	1.79334	6.7068	9:55
40	1.458	0.304	0.0944	1.26	4.8	0.443232	0.137635	1.83708	6.9984	11:35
40	1.458	0.438	0.113	0.619	3.4	0.638604	0.164754	0.902502	4.9572	17:30
40	1.458	0.5	0.091	1.19	3.1	0.729	0.132678	1.73502	4.5198	19:30
60	1.458	0.482	0.174	1.07	6.4	0.702756	0.253692	1.56006	9.3312	7:50
60	1.458	0.449	0.194	0.982	4.6	0.654642	0.282852	1.431756	6.7068	9:55
60	1.458	0.452	0.123	1.3	3.4	0.659016	0.179334	1.8954	4.9572	17:30
60	1.458	0.518	0.0963	1.12	3.1	0.755244	0.140405	1.63296	4.5198	19:30

80	1.458	0.458	0.147	0.89	6.3	0.667764	0.214326	1.29762	9.1854	7:50
80	1.458	0.48	0.193	1.11	4	0.69984	0.281394	1.61838	5.832	9:55
80	1.458	0.46	0.121	1.34	3.8	0.67068	0.176418	1.95372	5.5404	17:30
80	1.458	0.536	0.128	1.12	2.8	0.781488	0.186624	1.63296	4.0824	19:30
100	1.458	0.432	0.139	1.48	7.1	0.629856	0.202662	2.15784	10.3518	7:50
100	1.458	0.516	0.119	1.3	7.2	0.752328	0.173502	1.8954	10.4976	19:30
120	1.458	0.45	0.154	0.87	6.9	0.6561	0.224532	1.26846	10.0602	7:50
120	1.458	0.513	0.12	1.44	5.5	0.747954	0.17496	2.09952	8.019	19:30
140	1.458	0.478	0.129	1.32	5.5	0.696924	0.188082	1.92456	8.019	7:50
				Flux	Ebb	.481	-13.961	-4.512	29.576	
					Flood	22.266	-9.09	34.172	133.49	

2. Town Creek

a. Marsh Site, C-1.

		Conc. (μg-at l^{-1})				Mass (μg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.615	0.0899	0.15	3.5	0.448335	0.065537	0.10935	2.5515	9:35
10	0.729	0.572	0.0666	0.2	2.3	0.416988	0.048551	0.1458	1.6767	11:10
10	0.729	1.23	0.0342	0.17	4.9	0.89667	0.024932	0.12393	3.5721	19:00
20	0.729	0.5	0.0823	0.1	3.5	0.3645	0.059997	0.0729	2.5515	9:35
20	0.729	1.37	0.576	4.07	5.4	0.99873	0.419904	2.96703	3.9366	11:10
40	1.458	0.46	0.0747	0.11	3.5	0.67068	0.108913	0.16038	5.103	9:31
					Net Flux	-1.24	0.46	0.22	8.39	

APPENDIX C. (cont.)

2. Town Creek

b. Marsh Site, C-2.

		Conc. (μg-at l^{-1})				Mass (μg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.518	0.287	0.12	3.9	0.377622	0.209223	0.08748	2.8431	9:35
10	0.729	0.681	0.131	0.47	3.4	0.496449	0.095499	0.34263	2.4786	11:10
10	0.729	0.342	0.176	0.18	6.2	0.249318	0.128304	0.13122	4.5198	19:00
20	0.729	0.403	0.085	0.03	3.7	0.293787	0.061965	0.02187	2.6973	9:41
20	0.729	0.424	0.064	0.25	2.7	0.309096	0.046656	0.18225	1.9683	11:10
20	0.729	0.413	0.0706	0.15	4.2	0.301077	0.051467	0.10935	3.0618	19:00
40	1.458	0.491	0.111	0.19	4.3	0.715878	0.161838	0.27702	6.2694	9:31
40	1.458	0.358	0.0598	0.18	4	0.521964	0.087188	0.26244	5.832	19:00
					Net Flux	0.97	0.79	-1.46	59.15	

c. Bank Site, C-3.

		Conc. (μg-at l^{-1})				Mass (μg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.42	0.073	0.02	3.8	0.30618	0.053217	0.01458	2.7702	9:16
10	0.729	0.445	0.0674	0.25	3	0.324405	0.049135	0.18225	2.187	11:05
10	0.729	0.327	0.0908	0.46	5.9	0.238383	0.066193	0.33534	4.3011	16:50
10	0.729	0.308	0.0737	0.28	4.6	0.224532	0.053727	0.20412	3.3534	19:00
20	0.729	0.432	0.0765	0.09	4.4	0.314928	0.055769	0.06561	3.2076	9:16
20	0.729	0.389	0.0578	0.23	2.6	0.283581	0.042136	0.16767	1.8954	11:05
20	0.729	0.336	0.0658	0.16	4.6	0.244944	0.047968	0.11664	3.3534	19:00
40	1.458	0.505	0.0929	0.05	4.2	0.73629	0.135448	0.0729	6.1236	9:16

40	1.458	0.419	0.071	0.23	2.5	0.610902	0.103518	0.33534	3.645	11:05
40	1.458	0.353	0.0771	0.45	3.6	0.514674	0.112412	0.6561	5.2488	19:00
60	1.458	0.388	0.0789	4.9	4.4	0.565704	0.115036	7.1442	6.4152	9:16
60	1.458	0.385	0.0766	0.49	4.3	0.56133	0.111683	0.71442	6.2694	19:00
80	1.458	0.38	0.0968	0.12	4.9	0.55404	0.141134	0.17496	7.1442	9:16
80	1.458	0.405	0.0761	0.31	3.9	0.59049	0.110954	0.45198	5.6862	19:00
				Flux	Ebb	1.50	0.54	36.37	28.38	
					Flood	10.40	2.03	9.89	107.51	

d. Bank Site, C-4.

		Conc. (μg-at l^{-1})				Mass (μg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.4	0.0812	0.04	5.1	0.2916	0.059195	0.02916	3.7179	9:05
10	0.729	0.556	0.0945	0.55	3.3	0.405324	0.068891	0.40095	2.4057	11:05
10	0.729	0.663	0.125	0.57	2.9	0.483327	0.091125	0.41553	2.1141	16:50
10	0.729	0.548	0.184	0.28	5.4	0.399492	0.134136	0.20412	3.9366	19:00
20	0.729	0.482	0.0991	0.09	5.7	0.351378	0.072244	0.06561	4.1553	9:05
20	0.729	0.554	0.103	0.31	3.5	0.403866	0.075087	0.22599	2.5515	11:05
20	0.729	0.396	0.0875	0.14	4.5	0.288684	0.063788	0.10206	3.2805	11:05
40	1.458	0.424	0.0788	0.05	5.2	0.618192	0.11489	0.0729	7.5816	19:05
40	1.458	0.519	0.0967	0.38	3.4	0.756702	0.140989	0.55404	4.9572	11:05
40	1.458	0.308	0.0576	0.1	4.8	0.449064	0.083981	0.1458	6.9984	19:00
60	1.458	0.453	0.0807	0.08	5.2	0.660474	0.117661	0.11664	7.5816	9:05
60	1.458	0.334	0.0674	0.57	4.9	0.486972	0.098269	0.83106	7.1442	19:00
80	1.458	0.515	0.14	0.43	5	0.75087	0.20412	0.62694	7.29	9:05
80	1.458	0.326	0.0595	0.08	4.3	0.475308	0.086751	0.11664	6.2694	19:00
				Flux	Ebb	1.33	0.28	-3.27	49.56	
					Flood	8.86	2.06	5.46	139.88	

APPENDIX C. (cont.)

2. Town Creek

e. Creek Site, C-5

		Conc. (μg-at l^{-1})				Mass (μg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.429	0.0821	0.16	5.3	0.312741	0.059851	0.11664	3.8637	9:00
10	0.729	0.501	0.124	0.05	3.6	0.365229	0.090396	0.03645	2.6244	11:00
10	0.729	0.605	0.107	0.66	2.2	0.441045	0.078003	0.48114	1.6038	13:00
10	0.729	0.564	943	0.73	2.3	0.411156	687.447	0.53217	1.6767	15:00
10	0.729	0.353	0.0885	1.88	2	0.257337	0.064517	1.37052	1.458	17:00
10	0.729	0.546	0.0774	0.13	5.2	0.398034	0.056425	0.09477	3.7908	19:00
20	0.729	0.375	0.0753	0.41	5.1	0.273375	0.054894	0.29889	3.7179	9:00
20	0.729	0.598	0.0771	0.25	3	0.435942	0.056206	0.18225	2.187	11:00
20	0.729	0.407	0.081	0.27	2.1	0.296703	0.059049	0.19683	1.5309	13:00
20	0.729	0.536	0.0908	0.59	2	0.390744	0.066193	0.43011	1.458	15:00
20	0.729	0.305	0.0744	0.26	2	0.222345	0.054238	0.18954	1.458	17:00
20	0.729	0.458	0.0622	0.16	4.5	0.333882	0.045344	0.11664	3.2805	19:00
40	1.458	0.389	0.0813	0.08	5.4	0.567162	0.118535	0.11664	7.8732	9:00
40	1.458	0.49	0.063	0.16	3	0.71442	0.091854	0.23328	4.374	11:00
40	1.458	0.52	0.0912	0.32	2.3	0.75816	0.13297	0.46656	3.3534	15:00
40	1.458	0.315	0.0633	0.18	1.8	0.45927	0.092291	0.26244	2.6244	17:00
40	1.458	0.353	0.0587	0.19	4.6	0.514674	0.085585	0.27702	6.7068	19:00
60	1.458	0.492	0.0906	0.08	5	0.717336	0.132095	0.11664	7.29	9:00
60	1.458	0.494	0.0534	0.16	2.8	0.720252	0.077857	0.23328	4.0824	11:00
60	1.458	0.349	0.0705	0.19	2.2	0.508842	0.102789	0.27702	3.2076	17:00
60	1.458	0.528	0.0626	0.14	4.8	0.769824	0.091271	0.20412	6.9984	19:00

80	1.458	0.367	0.0854	0.07	4.7	0.535086	0.124513	0.10206	6.8526	9:00
80	1.458	0.64	0.0772	0.21	3.3	0.93312	0.112558	0.30618	4.8114	17:00
80	1.458	0.393	0.0557	0.18	5.2	0.572994	0.081211	0.26244	7.5816	19:00
100	1.458	0.359	0.0866	0.06	4.6	0.523422	0.126263	0.08748	6.7068	9:00
100	1.458	0.433	0.0555	0.18	2.8	0.631314	0.080919	0.26244	4.0824	17:00
100	1.458	0.33	0.0508	0.1	5.1	0.48114	0.074066	0.1458	7.4358	19:00
120	1.458	0.378	0.0735	0.05	4.8	0.551124	0.107163	0.0729	6.9984	9:00
120	1.458	0.341	0.0503	0.13	4.4	0.497178	0.073337	0.18954	6.4152	19:00
				Flux	Ebb	-1.67	1.51	-0.60	106.31	
					Flood	11.62	1.06	-4.43	183.45	

f. Creek Site, C-6.

	Conc. (μg-at l^{-1})					Mass (μg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.604	0.113	0.26	6.1	0.440316	0.082377	0.18954	4.4469	9:00
10	0.729	0.441	0.113	0.07	3.7	0.321489	0.082377	0.05103	2.6973	11:00
10	0.729	0.512	0.131	0.6	2.8	0.373248	0.095499	0.4374	2.0412	13:00
10	0.729	0.488	0.13	0.96	2.4	0.355752	0.09477	0.69984	1.7496	15:00
10	0.729	0.503	0.0813	0.66	2.4	0.366687	0.059268	0.48114	1.7496	17:00
10	0.729	0.577	0.206	0.45	6	0.420633	0.150174	0.32805	4.374	19:00
20	0.729	0.441	0.0795	0.18	6.4	0.321489	0.057956	0.13122	4.6656	9:00
20	0.729	0.346	0.0939	0	3.7	0.252234	0.068453	0	2.6973	11:00
20	0.729	0.524	0.09	0.33	2.4	0.381996	0.06561	0.24057	1.7496	13:00
20	0.729	0.645	0.119	0.5	2.8	0.470205	0.086751	0.3645	2.0412	15:00
20	0.729	0.437	0.0747	0.17	2.4	0.318573	0.054456	0.12393	1.7496	17:00
20	0.729	0.486	0.0899	0.29	5.5	0.354294	0.065537	0.21141	4.0095	19:00
40	1.458	0.455	0.0871	0.18	5.9	0.66339	0.126992	0.26244	8.6022	9:00

40	1.458	0.404	0.0904	0.06	3.8	0.589032	0.131803	0.08748	5.5404	11:00
40	1.458	0.547	0.0925	0.32	2.2	0.797526	0.134865	0.46656	3.2076	15:00
40	1.458	0.501	0.0728	0.18	2.2	0.730458	0.106142	0.26244	3.2076	17:00
40	1.458	0.494	0.0834	0.2	6	0.720252	0.121597	0.2916	8.748	19:00
60	1.458	0.449	0.0788	0.18	5.7	0.654642	0.11489	0.26244	8.3106	9:00
60	1.458	0.398	0.0756	-0.04	3.9	0.580284	0.110225	-0.05832	5.6862	11:00
60	1.458	0.453	0.0708	0.16	1.7	0.660474	0.103226	0.23328	2.4786	17:00
60	1.458	0.661	0.079	0.27	4.4	0.963738	0.115182	0.39366	6.4152	19:00
80	1.458	0.37	0.0784	0.1	5.6	0.53946	0.114307	0.1458	8.1648	9:00
80	1.458	0.376	0.0801	-0.02	3.4	0.548208	0.116786	-0.02916	4.9572	17:00
80	1.458	0.521	0.0652	0.1	5.7	0.759618	0.095062	0.1458	8.3106	19:00
100	1.458	0.36	0.078	0.12	5.1	0.52488	0.113724	0.17496	7.4358	9:00
100	1.458	0.438	0.0845	0.08	3.7	0.638604	0.123201	0.11664	5.3946	17:00
100	1.458	0.554	0.0573	0.17	5.5	0.807732	0.083543	0.24786	8.019	19:00
				Flux	Ebb	5.87	0.09	-3.44	125.10	
					Flood	10.69	1.69	2.95	168.26	

3. No Man's Friend

a. Marsh Site, C-1.

		Conc. (µg-at l^{-1})				Mass (µg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	1.03	0.552	4.15	5.7	0.75087	0.402408	3.02535	4.1553	9:17
10	0.729	1.02	0.45	4.58	5.7	0.74358	0.32805	3.33882	4.1553	10:55
10	0.729	0.658	0.715	1.51	5.7	0.479682	0.521235	1.10079	4.1553	12:45
10	0.729	0.988	0.18	3.82	5.7	0.720252	0.13122	2.78478	4.1553	20:57
20	0.729	1.02	0.575	3.47	5.7	0.74358	0.419175	2.52963	4.1553	9:17
20	0.729	0.956	0.43	3.39	5.7	1.393848	0.62694	4.94262	8.3106	10:55

20	0.729	0.692	0.46	0.79	5.7	0.504468	0.33534	0.57591	4.1553	12:45
20	0.729	0.839	0.42	1.95	5.7	0.611631	0.30618	1.42155	4.1553	20:57
40	1.458	0.997	0.814	2.56	5.7	1.453626	1.186812	3.73248	8.3106	9:17
40	1.458	0.811	0.988	1.59	5.7	1.182438	1.440504	2.31822	8.3106	10:55
40	1.458	1	0.552	1.67	5.7	1.458	0.804816	2.43486	8.3106	12:45
40	1.458	1.18	0.803	4.54	5.7	1.72044	1.170774	6.61932	8.3106	20:57
60	1.458	0.953	1.13	2.41	5.7	1.389474	1.64754	3.51378	8.3106	9:17
60	1.458	0.681	0.454	0.89	5.7	0.992898	0.661932	1.29762	8.3106	10:55
				Flux	Ebb	-6.29	4.08	-28.14	-45.56	

b. Marsh Site, C-2.

		Conc. (μg-at l^{-1})				Mass (μg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	1.32	0.575	6.86	5.7	0.96228	0.419175	5.00094	4.1553	9:17
10	0.729	1.74	0.458	7.96	5.7	1.26846	0.333882	5.80284	4.1553	10:55
10	0.729	1.61	0.444	7.4	5.7	1.17369	0.323676	5.3946	4.1553	12:45
10	0.729	1.52	0.448	17.7	5.7	1.10808	0.326592	12.9033	4.1553	20:57
20	0.729	1.12	0.713	4.81	5.7	0.81648	0.519777	3.50649	4.1553	9:17
20	0.729	1.81	0.473	5.7	5.7	2.63898	0.689634	8.3106	8.3106	10:55
20	0.729	1.11	0.479	4.03	5.7	0.80919	0.349191	2.93787	4.1553	12:45
20	0.729	1.6	0.376	18.58	5.7	1.1664	0.274104	13.54482	4.1553	20:57
40	1.458	1.16	0.706	3.96	5.7	1.69128	1.029348	5.77368	8.3106	9:17
40	1.458	1.88	0.456	9.02	5.7	2.74104	0.664848	13.15116	8.3106	10:55
40	1.458	0.697	0.558	24.4	5.7	1.016226	0.813564	35.5752	8.3106	12:45
40	1.458	1.73	0.581	18.78	5.7	2.52234	0.847098	27.38124	8.3106	20:57
60	1.458	1.23	0.53	5.83	5.7	1.79334	0.77274	8.50014	8.3106	9:17
60	1.458	1.32	0.501	6.87	5.7	1.92456	0.730458	10.01646	8.3106	10:55
				Flux	Ebb	-22.18	-0.64	-279.73	-45.56	

APPENDIX C. (cont.)

c. Bank Site, C-3.

		Conc. (μg-at l^{-1})				Mass (μg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	1.13	0.582	3.14	5.7	0.82377	0.424278	2.28906	4.1553	9:05
10	0.729	1.1	0.502	5.7	5.7	0.8019	0.365958	4.1553	4.1553	10:45
10	0.729	0.736	0.479	5.28	5.7	0.536544	0.349191	3.84912	4.1553	12:40
10	0.729	1.18	0.447	5.62	5.7	0.86022	0.325863	4.09698	4.1553	14:27
10	0.729	1.05	0.428	4.35	5.7	0.76545	0.312012	3.17115	4.1553	18:40
10	0.729	0.801	0.406	4.58	5.7	0.583929	0.295974	3.33882	4.1553	20:45
20	0.729	1.23	0.816	4.26	5.7	0.89667	0.594864	3.10554	4.1553	9:05
20	0.729	1.18	0.672	5.4	5.7	0.86022	0.489888	3.9366	4.1553	10:45
20	0.729	0.886	0.439	4.44	5.7	0.645894	0.320031	3.23676	4.1553	12:40
20	0.729	0.89	0.544	1.8	5.7	0.64881	0.396576	1.3122	4.1553	14:27
20	0.729	0.921	0.49	5.05	5.7	0.671409	0.35721	3.68145	4.1553	18:40
20	0.729	0.724	0.51	4.53	5.7	0.527796	0.37179	3.30237	4.1553	20:45
40	1.458	1.07	0.71	2.77	4.9	1.56006	1.03518	4.03866	7.1442	12:40
40	1.458	1.17	0.506	4.77	7	1.70586	0.737748	6.95466	10.206	14:27
40	1.458	0.934	0.381	1.81	4.4	1.361772	0.555498	2.63898	6.4152	18:40
40	1.458	0.781	0.511	4.43	3.5	1.138698	0.745038	6.45894	5.103	20:45
60	1.458	1.03	0.609	2.98	5.4	1.50174	0.887922	4.34484	7.8732	12:40
60	1.458	0.956	0.513	2.87	6	1.393848	0.747954	4.18446	8.748	14:27
60	1.458	0.72	0.61	1.29	4.8	1.04976	0.88938	1.88082	6.9984	18:40
60	1.458	0.801	0.545	4.31	3.5	1.167858	0.79461	6.28398	5.103	20:45
				Flux	Ebb	4.53	2.11	-21.46	26.38	

APPENDIX C. (cont.)

d. Bank Site, C-4.

	Conc. (μg-at l^{-1})					Mass (μg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	1.21	0.615	3.35	6.2	0.88209	0.448335	2.44215	4.5198	
10	0.729	1.11	0.492	4.58	4.6	0.80919	0.358668	3.33882	3.3534	20:30
10	0.729	0.678	0.392	2.48	4.6	0.494262	0.285768	1.80792	3.3534	10:45
10	0.729	0.977	0.505	2.32	5.9	0.712233	0.368145	1.69128	4.3011	12:40
10	0.729	1.03	0.801	5.03	7.7	0.75087	0.583929	3.66687	5.6133	14:37
10	0.729	0.917	0.89	3.12	22.4	0.668493	0.64881	2.27448	16.3296	18:40
20	0.729	1.2	0.729	2.98	5.7	0.8748	0.531441	2.17242	4.1553	20:45
20	0.729	1.15	0.499	4.34	4.6	0.83835	0.363771	3.16386	3.3534	9:05
20	0.729	0.993	0.524	2.84	5	0.723897	0.381996	2.07036	3.645	10:45
20	0.729	1.09	0.622	2.45	5.3	0.79461	0.453438	1.78605	3.8637	12:40
20	0.729	1.37	2.02	7.51	9.2	0.99873	1.47258	5.47479	6.7068	14:37
20	0.729	0.938	0.441	2.95	9.7	0.683802	0.321489	2.15055	7.0713	18:40
40	1.458	1.18	0.667	2.5	6	1.72044	0.972486	3.645	8.748	20:45
40	1.458	1.01	0.533	2.41	6.7	1.47258	0.777114	3.51378	9.7686	9:05
40	1.458	0.949	0.413	1.79	5.1	1.383642	0.602154	2.60982	7.4358	10:45
40	1.458	0.902	0.454	2.92	5.8	1.315116	0.661932	4.25736	8.4564	12:40
60	1.458	1.11	0.644	2.72	6.4	1.61838	0.938952	3.96576	9.3312	20:45
60	1.458	1.4	0.529	3.8	7.5	2.0412	0.771282	5.5404	10.935	9:05
60	1.458	0.939	0.478	2.13	5	1.369062	0.696924	3.10554	7.29	10:45
60	1.458	0.888	0.505	0.297	7	1.294704	0.73629	0.433026	10.206	12:40
80	1.458	1.35	0.656	5.19	5.7	1.9683	0.956448	7.56702	8.3106	20:45
80	1.458	1.07	0.556	3.16	6.8	1.56006	0.810648	4.60728	9.9144	9:05
				Flux	Ebb	5.85	-1.10	-12.85	8.81	
					Flood	17.86	1.71	-0.14	163.07	

APPENDIX C. (cont.)

e. Creek Site, C-5.

		Conc. (μg-at l^{-1})				Mass (μg-at)				
10	0.729	1.91	0.677	5.45	7.2	1.39239	0.493533	3.97305	5.2488	8:30
10	0.729	1.9	0.548	7.37	5.5	1.3851	0.399492	5.37273	4.0095	10:30
10	0.729	1.82	0.364	8.88	6.4	1.32678	0.265356	6.47352	4.6656	12:30
10	0.729	1.19	0.542	2.54	6	0.86751	0.395118	1.85166	4.374	14:30
10	0.729	3.41	2.08	20.2	16	2.48589	1.51632	14.7258	11.664	18:40
10	0.729	2.13	0.43	8.91	5.4	1.55277	0.31347	6.49539	3.9366	20:30
20	0.729	1.59	0.659	5.34	7.6	1.15911	0.480411	3.89286	5.5404	8:30
20	0.729	1.57	0.51	6.22	5.4	1.14453	0.37179	4.53438	3.9366	10:30
20	0.729	1.29	0.412	3.61	5.7	0.94041	0.300348	2.63169	4.1553	12:30
20	0.729	1.28	0.476	3.84	6.2	0.93312	0.347004	2.79936	4.5198	14:30
20	0.729	3.18	2.36	16.64	10.3	2.31822	1.72044	12.13056	7.5087	18:30
20	0.729	1.5	0.598	7.28	6.4	1.0935	0.435942	5.30712	4.6656	20:30
40	1.458	1.16	0.55	2.45	7.1	1.69128	0.8019	3.5721	10.3518	8:30
40	1.458	1.75	0.534	7.37	5.2	2.5515	0.778572	10.74546	7.5816	10:30
40	1.458	1.18	0.385	2.96	6	1.72044	0.56133	4.31568	8.748	12:30
40	1.458	1.46	0.676	7.05	7.5	2.12868	0.985608	10.2789	10.935	20:30
60	1.458	1.12	0.621	2.66	6.4	1.63296	0.905418	3.87828	9.3312	8:30
60	1.458	1.6	0.467	6.89	4.9	2.3328	0.680886	10.04562	7.1442	10:30
60	1.458	1.21	0.401	3.03	6.1	1.76418	0.584658	4.41774	8.8938	12:30
60	1.458	2.57	2.25	16.24	6.3	3.74706	3.2805	23.67792	9.1854	20:30
80	1.458	1.21	0.448	3.95	5.1	1.76418	0.653184	5.7591	7.4358	20:30
				Flux	Ebb	-30.15	-10.87	-2.63	-91.72	
					Flood	30.06	13.33	135.21	93.12	

APPENDIX C. (cont.)

f. Creek Site, C-6.

		Conc. (μg-at l^{-1})				Mass (μg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	1.37	0.576	4.07	5.4	0.99873	0.419904	2.96703	3.9366	8:30
10	0.729	2.95	0.546	6.28	6.9	2.15055	0.398034	4.57812	5.0301	10:30
10	0.729	3.42	0.517	5.72	7	2.49318	0.376893	4.16988	5.103	12:30
10	0.729	8.49	0.566	7.16	6.7	6.18921	0.412614	5.21964	4.8843	14:30
10	0.729	29.2	4.03	106.8	15	21.2868	2.93787	77.8572	10.935	18:40
10	0.729	5.34	0.71	12.1	6.1	3.89286	0.51759	8.8209	4.4469	20:30
20	0.729	1.18	0.649	3.36	5.2	0.86022	0.473121	2.44944	3.7908	8:30
20	0.729	2.95	0.528	4.42	5.6	2.15055	0.384912	3.22218	4.0824	10:30
20	0.729	4.69	0.48	5.77	6.8	3.41901	0.34992	4.20633	4.9572	12:30
20	0.729	9.1	0.55	7.42	8.4	6.6339	0.40095	5.40918	6.1236	14:30
20	0.729	21.2	3.17	101.6	15.9	15.4548	2.31093	74.0664	11.5911	18:30
20	0.729	4.89	0.722	11.34	9.2	3.56481	0.526338	8.26686	6.7068	20:30
40	1.458	1.47	0.644	2.89	4.9	2.14326	0.938952	4.21362	7.1442	8:30
40	1.458	4.29	0.764	3.83	5.5	6.25482	1.113912	5.58414	8.019	10:30
40	1.458	9.49	0.456	7.48	6.8	13.83642	0.664848	10.90584	9.9144	12:30
40	1.458	9.48	1.24	36.6	6.2	13.82184	1.80792	53.3628	9.0396	20:30
60	1.458	2.75	0.924	5.57	4.9	4.0095	1.347192	8.12106	7.1442	8:30
60	1.458	10.6	0.603	8.61	6.1	15.4548	0.879174	12.55338	8.8938	10:30
60	1.458	5.71	0.403	4.45	6.7	8.32518	0.587574	6.4881	9.7686	12:30
60	1.458	21.5	2.92	132.4	7.7	31.347	4.25736	193.0392	11.2266	20:30
80	1.458	26.3	1.54	56.2	8.5	38.3454	2.24532	81.9396	12.393	8:30
80	1.458	8.16	0.464	7.09	6.5	11.89728	0.676512	10.33722	9.477	10:30
100	1.458	7.63	0.548	6.31	7	11.12454	0.798984	9.19998	10.206	20:30
				Flux	Ebb	-79.13	-10.96	-434.84	-94.32	
					Flood	148.08	14.58	662.10	104.71	

APPENDIX D. Nutrient Data from benthic chambers. 1992.

1. Oyster Landing

a. Marsh Site, C-1.

		Conc. (μg-at l^{-1})				Mass (μg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.873	0.978	2.19	8.9	0.636417	0.712962	1.59651	6.4881	9:00
10	0.729	0.37	0.98	2.19	8.9	0.26973	0.71442	1.59651	6.4881	11:00
10	0.729	0.31	1.08	2.11	4.7	0.22599	0.78732	1.53819	3.4263	13:00
10	0.729	0.5	1.45	2.87	4.5	0.3645	1.05705	2.09223	3.2805	15:00
10	0.729	0.64	1.61	5.79	2.1	0.46656	1.17369	4.22091	1.5309	17:00
20	0.729	0.28	0.72	1.72	8.6	0.20412	0.52488	1.25388	6.2694	11:00
20	0.729	0.27	1.47	3.18	4.2	0.19683	1.07163	2.31822	3.0618	13:00
20	0.729	0.48	1.45	2.79	4.7	0.34992	1.05705	2.03391	3.4263	15:00
20	0.729	0.54	1.44	3.44	2	0.39366	1.04976	2.50776	1.458	17:00
40	1.458	0.39	1.18	2.73	8.1	0.56862	1.72044	3.98034	11.8098	11:00
40	1.458	0.45	1.57	2.66	4.7	0.6561	2.28906	3.87828	6.8526	13:00
40	1.458	0.42	1.41	2.26	4.3	0.61236	2.05578	3.29508	6.2694	15:00
40	1.458	0.43	1.24	2.6	1.4	0.62694	1.80792	3.7908	2.0412	17:00
60	1.458	0.39	1.65	2.5	5.1	0.56862	2.4057	3.645	7.4358	13:00
60	1.458	0.45	1.37	2.11	4	0.6561	1.99746	3.07638	5.832	15:00
60	1.458	0.49	1.38	2.95	2	0.71442	2.01204	4.3011	2.916	17:00
80	1.458	0.4	1.59	2.03	5.1	0.5832	2.31822	2.95974	7.4358	13:00
80	1.458	0.32	1.15	2.12	3.8	0.46656	1.6767	3.09096	5.5404	15:00
80	1.458	0.41	1.12	2	1.9	0.59778	1.63296	2.916	2.7702	17:00
				Flux	Flood	7.87	23.80	54.48	-85.93	

APPENDIX D. (cont.)

b. Marsh Site, C-2.

		Conc. (μg-at l^{-1})				Mass (μg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.842	1.32	6.79	7.1	0.613818	0.96228	4.94991	5.1759	9:00
10	0.729	0.46	1.1	2.43	7.4	0.33534	0.8019	1.77147	5.3946	11:00
10	0.729	0.32	0.99	1.39	7.6	0.23328	0.72171	1.01331	5.5404	13:00
10	0.729	0.47	0.88	2.7	4.2	0.34263	0.64152	1.9683	3.0618	15:00
10	0.729	0.3	0.75	2.86	1	0.2187	0.54675	2.08494	0.729	17:00
20	0.729	0.4	1.02	2.19	7	0.2916	0.74358	1.59651	5.103	11:00
20	0.729	0.38	1	2.27	5.1	0.27702	0.729	1.65483	3.7179	13:00
20	0.729	0.42	1	2.21	5.1	0.30618	0.729	1.61109	3.7179	15:00
20	0.729	0.46	1.05	3.19	2.4	0.33534	0.76545	2.32551	1.7496	17:00
40	1.458	0.71	1.17	6.83	7.6	1.03518	1.70586	9.95814	11.0808	11:00
40	1.458	0.43	1.21	2.35	5.7	0.62694	1.76418	3.4263	8.3106	13:00
40	1.458	0.32	1.01	2.39	4.5	0.46656	1.47258	3.48462	6.561	15:00
40	1.458	0.45	0.99	2.78	2.5	0.6561	1.44342	4.05324	3.645	17:00
60	1.458	0.31	0.98	1.96	4.3	0.45198	1.42884	2.85768	6.2694	13:00
60	1.458	0.38	1.04	1.76	4.8	0.55404	1.51632	2.56608	6.9984	15:00
60	1.458	0.44	1	2.9	2.4	0.64152	1.458	4.2282	3.4992	17:00
80	1.458	0.43	1.04	4.79	4.3	0.62694	1.51632	6.98382	6.2694	13:00
80	1.458	0.42	1.02	2.09	4.8	0.61236	1.48716	3.04722	6.9984	15:00
80	1.458	0.36	0.85	2.46	2.1	0.52488	1.2393	3.58668	3.0618	17:00
				Flux	Flood	2.07	7.62	12.23	-83.13	

APPENDIX D. (cont.)

c. Bank Sites, C-3.

		Conc. (μg-at l^{-1})				Mass (μg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.36	1.53	10.6	8.1	0.26244	1.11537	7.7274	5.9049	11:00
10	0.729	0.48	2.33	9.8	4.7	0.34992	1.69857	7.1442	3.4263	13:00
10	0.729	0.34	1.99	7.14	4.4	0.24786	1.45071	5.20506	3.2076	15:00
10	0.729	0.33	1.98	8.39	4	0.24057	1.44342	6.11631	2.916	17:00
20	0.729	0.52	1.8	9.98	9	0.37908	1.3122	7.27542	6.561	11:00
20	0.729	0.41	2.15	9.5	4.3	0.29889	1.56735	6.9255	3.1347	13:00
20	0.729	0.3	1.94	6.13	4.4	0.2187	1.41426	4.46877	3.2076	15:00
20	0.729	0.37	1.94	7.95	3.5	0.26973	1.41426	5.79555	2.5515	17:00
30	0.729	0.55	2.06	1.8	8.4	0.40095	1.50174	1.3122	6.1236	11:00
30	0.729	0.54	2.43	10.1	4.6	0.39366	1.77147	7.3629	3.3534	13:00
30	0.729	0.28	1.88	5.98	4.2	0.20412	1.37052	4.35942	3.0618	15:00
30	0.729	0.37	1.94	7.75	3.3	0.26973	1.41426	5.64975	2.4057	17:00
40	1.458	0.46	2.23	9.12	4.6	0.67068	3.25134	13.29696	6.7068	13:00
40	1.458	0.38	1.71	5.19	3.9	0.55404	2.49318	7.56702	5.6862	15:00
40	1.458	0.39	1.95	7.75	3	0.56862	2.8431	11.2995	4.374	17:00
60	1.458	0.5	2.48	11	4.6	0.729	3.61584	16.038	6.7068	13:00
60	1.458	0.22	1.7	5.4	3.7	0.32076	2.4786	7.8732	5.3946	15:00
60	1.458	0.4	1.96	7.78	2.8	0.5832	2.85768	11.34324	4.0824	17:00
80	1.458	0.24	1.6	5.05	3.6	0.34992	2.3328	7.3629	5.2488	15:00
				Flux	Flood	3.28	25.34	100.00	-24.38	

APPENDIX D. (cont.)

d. Bank Site, C-4.

		Conc. (μg-at l^{-1})				Mass (μg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.32	0.99	2.6	7.2	0.23328	0.72171	1.8954	5.2488	11:00
10	0.729	0.74	1.52	1.56	5.1	0.53946	1.10808	1.13724	3.7179	13:00
10	0.729	0.11	1.03	0.48	4.8	0.08019	0.75087	0.34992	3.4992	15:00
10	0.729	0.2	1.1	0.78	5.4	0.1458	0.8019	0.56862	3.9366	17:00
20	0.729	0.27	1.52	4.09	8	0.19683	1.10808	2.98161	5.832	11:00
20	0.729	0.26	1.58	1.86	4.8	0.18954	1.15182	1.35594	3.4992	13:00
20	0.729	0.1	0.78	0.24	4	0.0729	0.56862	0.17496	2.916	15:00
20	0.729	0.2	1.1	0.4	5	0.1458	0.8019	0.2916	3.645	17:00
30	0.729	0.36	2.47	6.33	7.3	0.26244	1.80063	4.61457	5.3217	11:00
30	0.729	0.25	1.45	1.72	5.1	0.18225	1.05705	1.25388	3.7179	13:00
30	0.729	0.11	1.16	0.24	4.4	0.08019	0.84564	0.17496	3.2076	15:00
30	0.729	0.15	0.94	1.28	5	0.10935	0.68526	0.93312	3.645	17:00
40	1.458	0.27	1.49	2.07	4.4	0.39366	2.17242	3.01806	6.4152	13:00
40	1.458	0.19	1.13	0.28	4.3	0.27702	1.64754	0.40824	6.2694	15:00
40	1.458	0.09	0.74	0.48	4.1	0.13122	1.07892	0.69984	5.9778	17:00
60	1.458	0.15	1.7	2.03	4.5	0.2187	2.4786	2.95974	6.561	13:00
60	1.458	0.17	0.89	0.29	4.7	0.24786	1.29762	0.42282	6.8526	15:00
60	1.458	0.18	1.03	0.43	4.5	0.26244	1.50174	0.62694	6.561	17:00
80	1.458	0.13	0.89	0.32	3.9	0.18954	1.29762	0.46656	5.6862	15:00
				Flux	Flood	0.16	3.83	-36.87	23.98	

APPENDIX D. (cont.)

e. Creek Site, C-5.

		Conc. (µg-at l^{-1})				Mass (µg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.553	1.56	2.88	27.4	0.403137	1.13724	2.09952	19.9746	9:00
10	0.729	0.64	2.35	6.13	18.5	0.46656	1.71315	4.46877	13.4865	11:00
10	0.729	1.81	1.45	13.2	5	1.31949	1.05705	9.6228	3.645	13:00
10	0.729	1.81	1.99	14.3	5.8	1.31949	1.45071	10.4247	4.2282	15:00
10	0.729	1.79	2.6	14.7	5.7	1.30491	1.8954	10.7163	4.1553	17:00
20	0.729	0.49	1.9	4.9	15.3	0.35721	1.3851	3.5721	11.1537	9:00
20	0.729	0.29	1.91	3.73	20.7	0.21141	1.39239	2.71917	15.0903	11:00
20	0.729	1.92	1.53	14	5.1	1.39968	1.11537	10.206	3.7179	13:00
20	0.729	1.36	1.55	12	4.8	0.99144	1.12995	8.748	3.4992	15:00
20	0.729	1.76	2.45	13.1	5.4	1.28304	1.78605	9.5499	3.9366	17:00
40	1.458	0.45	1.58	5.44	20	0.6561	2.30364	7.93152	29.16	9:00
40	1.458	0.22	0.92	3.71	12.5	0.32076	1.34136	5.40918	18.225	11:00
40	1.458	1.86	1.37	12	5	2.71188	1.99746	17.496	7.29	13:00
40	1.458	1.39	1.58	10.2	6	2.02662	2.30364	14.8716	8.748	15:00
40	1.458	1.49	1.82	17.6	4.4	2.17242	2.65356	25.6608	6.4152	17:00
60	1.458	0.28	0.87	3.53	13.2	0.40824	1.26846	5.14674	19.2456	11:00
60	1.458	2.11	1.49	14.9	5.2	3.07638	2.17242	21.7242	7.5816	13:00
60	1.458	1.89	1.71	13.7	6	2.75562	2.49318	19.9746	8.748	15:00
60	1.458	1.74	1.82	14.6	5.5	2.53692	2.65356	21.2868	8.019	17:00
80	1.458	0.38	2.46	3.21	17	0.55404	3.58668	4.68018	24.786	13:00
80	1.458	1.83	1.71	12.5	6.2	2.66814	2.49318	18.225	9.0396	15:00
80	1.458	1.95	1.81	16.8	5.4	2.8431	2.63898	24.4944	7.8732	17:00
100	1.458	0.31	1.82	5.18	19.7	0.45198	2.65356	7.55244	28.7226	13:00

100	1.458	2.69	1.89	26.2	6.9	3.92202	2.75562	38.1996	10.0602	15:00
100	1.458	0.54	25.7	7.16	19.2	0.78732	37.4706	10.43928	27.9936	17:00
120	1.458	0.45	3.16	5.64	26.2	0.6561	4.60728	8.22312	38.1996	15:00
120	1.458	0.4	2.39	5.57	27.1	0.5832	3.48462	8.12106	39.5118	17:00
				Flux	Flood	-92.69	266.09	535.44	292.24	

f. Creek Site, C-6.

		Conc. (μg-at l^{-1})				Mass (μg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.825	1.08	13.6	11.2	0.601425	0.78732	9.9144	8.1648	9:00
10	0.729	0.37	1.63	2.13	6.5	0.26973	1.18827	1.55277	4.7385	11:00
10	0.729	0.39	1.94	2.28	4.6	0.28431	1.41426	1.66212	3.3534	13:00
10	0.729	0.35	1.68	1.95	4.4	0.25515	1.22472	1.42155	3.2076	15:00
10	0.729	0.41	2.47	2.44	5.7	0.29889	1.80063	1.77876	4.1553	17:00
20	0.729	0.38	1.12	3.21	20.5	0.27702	0.81648	2.34009	14.9445	9:00
20	0.729	0.11	1	2.16	8.3	0.08019	0.729	1.57464	6.0507	11:00
20	0.729	0.38	2.02	2.28	4.6	0.27702	1.47258	1.66212	3.3534	13:00
20	0.729	0.31	1.75	1.6	4.4	0.22599	1.27575	1.1664	3.2076	15:00
20	0.729	0.39	2.28	2.54	5.4	0.28431	1.66212	1.85166	3.9366	17:00
40	1.458	0.48	1.2	5.2	23.3	0.69984	1.7496	7.5816	33.9714	9:00
40	1.458	0.29	1.12	4.41	8.4	0.42282	1.63296	6.42978	12.2472	11:00
40	1.458	0.25	1.19	2.11	3.4	0.3645	1.73502	3.07638	4.9572	13:00
40	1.458	0.33	1.7	1.69	4.4	0.48114	2.4786	2.46402	6.4152	15:00
40	1.458	0.32	1.86	1.92	4.3	0.46656	2.71188	2.79936	6.2694	17:00
60	1.458	0.34	1.36	3.08	21.2	0.49572	1.98288	4.49064	30.9096	11:00
60	1.458	0.4	2.13	2.19	4.5	0.5832	3.10554	3.19302	6.561	13:00
60	1.458	0.26	1.59	1.32	4.2	0.37908	2.31822	1.92456	6.1236	15:00

60	1.458	0.43	2.27	2.77	5.6	0.62694	3.30966	4.03866	8.1648	17:00
80	1.458	0.5	1.98	3.39	4.8	0.729	2.88684	4.94262	6.9984	13:00
80	1.458	0.25	1.7	1.75	4.8	0.3645	2.4786	2.5515	6.9984	15:00
80	1.458	0.45	2.22	3.12	5.6	0.6561	3.23676	4.54896	8.1648	17:00
100	1.458	0.35	2.06	3.81	22.3	0.5103	3.00348	5.55498	32.5134	13:00
100	1.458	0.5	2.11	3.74	5.9	0.729	3.07638	5.45292	8.6022	15:00
100	1.458	0.36	1.86	4.71	21.4	0.52488	2.71188	6.86718	31.2012	17:00
120	1.458	0.31	2.02	3.35	22.8	0.45198	2.94516	4.8843	33.2424	15:00
120	1.458	0.35	1.73	4.67	22.7	0.5103	2.52234	6.80886	33.0966	17:00
				Flux	Flood	42.286	81.073	98.839	198.237	

2. Town Creek

a. Marsh Site, C-1

		Conc. (µg-at l^{-1})				Mass (µg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.318	0.176	0.57	4.3	0.231822	0.128304	0.41553	3.1347	13:00
10	0.729	0.287	0.101	0.5	4.3	0.209223	0.073629	0.3645	3.1347	15:00
10	0.729	0.27	0.119	0.55	3.3	0.19683	0.086751	0.40095	2.4057	13:00
20	0.729	0.49	0.387	0.63	4.3	0.35721	0.282123	0.45927	3.1347	15:00
40	1.458	0.491	0.111	0.19	4.3	0.715878	0.161838	0.27702	6.2694	13:00
40	1.458	0.358	0.0598	0.18	4	0.521964	0.087188	0.26244	5.832	15:00
60	1.458	0.237	0.13	0.45	4.1	0.345546	0.18954	0.6561	5.9778	15:00
80	1.458	0.289	0.102	0.39	3.7	0.421362	0.148716	0.56862	5.3946	15:00
				Flux	Flood	3.90	2.22	6.64	64.05	

APPENDIX D. (cont.)

2. Town Creek

b. Marsh Site, C-2.

		Conc. (µg-at l^{-1})				Mass (µg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.292	0.103	0.67	4.1	0.212868	0.075087	0.48843	2.9889	13:00
10	0.729	0.5	0.0948	0.6	5.2	0.3645	0.069109	0.4374	3.7908	15:00
20	0.729	0.28	0.0829	0.57	3.9	0.20412	0.060434	0.41553	2.8431	13:00
20	0.729	0.303	0.0882	0.43	4.6	0.220887	0.064298	0.31347	3.3534	15:00
40	1.458	0.284	0.0693	0.36	4.5	0.414072	0.101039	0.52488	6.561	15:00
40	1.458	0.285	0.087	0.41	4.7	0.41553	0.126846	0.59778	6.8526	15:00
40	1.458	0.284	0.144	0.43	4.4	0.414072	0.209952	0.62694	6.4152	15:00
				Flux	Flood	7.74	0.46	-0.17	36.99	

c. Bank Site, C-3

		Conc. (µg-at l^{-1})				Mass (µg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.285	0.288	0.86	4	0.207765	0.209952	0.62694	2.916	11:00
10	0.729	1.05	0.163	6.97	5.1	0.76545	0.118827	5.08113	3.7179	13:00
20	0.729	0.263	0.262	0.83	3.9	0.191727	0.190998	0.60507	2.8431	11:00
20	0.729	0.834	0.156	5.91	3.7	0.607986	0.113724	4.30839	2.6973	13:00
40	1.458	0.271	0.264	0.91	3.9	0.395118	0.384912	1.32678	5.6862	11:00
40	1.458	0.701	0.255	4.47	4.6	1.022058	0.37179	6.51726	6.7068	15:00
60	1.458	0.881	0.227	6.2	4.4	1.284498	0.330966	9.0396	6.4152	15:00
				Flux	Flood	8.29	-0.46	71.27	9.19	

APPENDIX D. (cont.)

2. Town Creek

d. Bank Site, C-4.

		Conc. (μg-at l^{-1})				Mass (μg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.33	0.303	1.23	3.9	0.24057	0.220887	0.89667	2.8431	11:00
10	0.729	0.758	0.145	3.08	4.1	0.552582	0.105705	2.24532	2.9889	13:00
10	0.729	0.582	0.137	3.11	3.2	0.424278	0.099873	2.26719	2.3328	15:00
20	0.729	0.309	0.299	1.2	4	0.225261	0.217971	0.8748	2.916	11:00
20	0.729	0.77	0.201	3.95	4.4	0.56133	0.146529	2.87955	3.2076	13:00
20	0.729	0.881	0.155	4.68	3.3	0.642249	0.112995	3.41172	2.4057	15:00
40	1.458	0.299	0.304	1.34	3.9	0.435942	0.443232	1.95372	5.6862	11:00
40	1.458	0.829	0.175	4.56	4.8	1.208682	0.25515	6.64848	6.9984	13:00
40	1.458	0.348	0.159	1	6.5	0.507384	0.231822	1.458	9.477	15:00
60	1.458	0.694	0.229	3.37	5.2	1.011852	0.333882	4.91346	7.5816	13:00
60	1.458	0.533	0.178	3.19	5.5	0.777114	0.259524	4.65102	8.019	15:00
80	1.458	0.405	0.0761	0.31	3.9	0.59049	0.110954	0.45198	5.6862	15:00
				Flux	Flood	11.18	-0.37	46.67	90.33	

APPENDIX D. (cont.)

2. Town Creek

e. Creek Site, C-5.

		Conc. (µg-at l^{-1})				Mass (µg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.629	0.325	1.29	3.7	0.458541	0.236925	0.94041	2.6973	11:00
10	0.729	33.15	0.49	4.58	4.1	24.16635	0.35721	3.33882	2.9889	13:00
10	0.729	7.43	0.533	65.8	4.2	5.41647	0.388557	47.9682	3.0618	15:00
20	0.729	0.473	0.332	0.81	4.5	0.344817	0.242028	0.59049	3.2805	11:00
20	0.729	3.51	0.481	6.15	6.3	2.55879	0.350649	4.48335	4.5927	13:00
20	0.729	1.73	0.346	11.4	3.7	1.26117	0.252234	8.3106	2.6973	15:00
40	1.458	0.392	0.329	0.78	4.4	0.571536	0.479682	1.13724	6.4152	11:00
40	1.458	2.18	0.474	4.88	5.5	3.17844	0.691092	7.11504	8.019	13:00
40	1.458	0.795	0.14	5.09	5.1	1.15911	0.20412	7.42122	7.4358	15:00
60	1.458	0.32	0.291	0.79	4	0.46656	0.424278	1.15182	5.832	11:00
60	1.458	1.35	0.408	2.15	5.7	1.9683	0.594864	3.1347	8.3106	13:00
60	1.458	0.84	0.152	6.19	6.1	1.22472	0.221616	9.02502	8.8938	15:00
80	1.458	2.49	0.386	3.14	4.8	3.63042	0.562788	4.57812	6.9984	13:00
80	1.458	0.809	0.147	5.8	5.5	1.179522	0.214326	8.4564	8.019	15:00
100	1.458	0.853	0.126	3.27	5.4	1.243674	0.183708	4.76766	7.8732	15:00
120	1.458	0.885	0.162	4.34	4.9	1.29033	0.236196	6.32772	7.1442	15:00
				Flux	Flood	59.94	1.53	484.94	147.48	

APPENDIX D. (cont.)

2. Town Creek

e. Creek Site, C-6

		Conc. (µg-at l^{-1})				Mass (µg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.311	0.348	0.89	4.2	0.226719	0.253692	0.64881	3.0618	11:00
10	0.729	1.18	0.407	1.85	5.2	0.86022	0.296703	1.34865	3.7908	13:00
10	0.729	0.453	0.087	0.96	2.9	0.330237	0.063423	0.69984	2.1141	15:00
20	0.729	0.274	0.344	0.99	4	0.199746	0.250776	0.72171	2.916	11:00
20	0.729	0.969	0.427	3.33	5	0.706401	0.311283	2.42757	3.645	13:00
20	0.729	0.309	0.0636	6.57	2.7	0.225261	0.046364	4.78953	1.9683	15:00
40	1.458	0.473	0.344	1.34	4.1	0.689634	0.501552	1.95372	5.9778	11:00
40	1.458	0.879	0.408	3.01	4.7	1.281582	0.594864	4.38858	6.8526	13:00
40	1.458	0.773	0.14	4.19	5.8	1.127034	0.20412	6.10902	8.4564	15:00
60	1.458	0.337	0.334	0.89	4.1	0.491346	0.486972	1.29762	5.9778	11:00
60	1.458	0.693	0.442	3.69	4.7	1.010394	0.644436	5.38002	6.8526	13:00
80	1.458	0.682	0.388	3.44	4.8	0.994356	0.565704	5.01552	6.9984	13:00
				Flux	Flood	17.79	5.04	76.37	55.95	

APPENDIX D. (cont.)

3. No Man's Friend

a. Marsh Site, C-1.

		Conc. (μg-at l^{-1})				Mass (μg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.48	0.409	0.792	5.1	0.34992	0.298161	0.577368	3.7179	13:00
10	0.729	0.346	0.063	0.111	5	0.252234	0.045927	0.080919	3.645	15:00
10	0.729	0.506	0.065	0.252	5.1	0.368874	0.047385	0.183708	3.7179	17:00
20	0.729	0.345	0.258	0.493	6.2	0.251505	0.188082	0.359397	4.5198	13:00
20	0.729	0.466	0.06	0.266	4.6	0.679428	0.08748	0.387828	6.7068	15:00
20	0.729	0.362	0.07	0.654	4.4	0.263898	0.05103	0.476766	3.2076	17:00
40	1.458	0.35	0.658	2.57	4.7	0.5103	0.959364	3.74706	6.8526	13:00
40	1.458	0.267	0.058	0.487	4	0.389286	0.084564	0.710046	5.832	15:00
40	1.458	0.354	0.1	0.206	5.2	0.516132	0.1458	0.300348	7.5816	17:00
60	1.458	0.305	0.221	0.832	3.9	0.44469	0.322218	1.213056	5.6862	15:00
60	1.458	0.35	0.276	1.79	4.3	0.5103	0.402408	2.60982	6.2694	17:00
80	1.458	0.487	0.261	1.13	9.8	0.710046	0.380538	1.64754	14.2884	13:20
80	1.458	0.329	0.076	1.56	8.2	0.479682	0.110808	2.27448	11.9556	15:20
				Flux	Flood	-0.22	-1.62	-3.78	-11.79	

APPENDIX D. (cont.)

3. No Man's Friend

b. Marsh Site, C-2.

		Conc. (μg-at l^{-1})				Mass (μg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.565	1.2	1.58	6.8	0.411885	0.8748	1.15182	4.9572	13:00
10	0.729	0.486	0.892	1.53	6.4	0.354294	0.650268	1.11537	4.6656	15:00
10	0.729	0.387	1.03	2.74	8.3	0.282123	0.75087	1.99746	6.0507	17:00
20	0.729	0.573	1.47	2.52	7.6	0.417717	1.07163	1.83708	5.5404	13:00
20	0.729	0.551	0.949	0.453	6.9	0.803358	1.383642	0.660474	10.0602	15:00
20	0.729	0.321	0.707	2.44	7.1	0.234009	0.515403	1.77876	5.1759	17:00
40	1.458	0.414	0.867	2.77	4.8	0.603612	1.264086	4.03866	6.9984	13:00
40	1.458	0.539	0.94	1.48	7.6	0.785862	1.37052	2.15784	11.0808	15:00
40	1.458	0.409	1.04	2.98	7.5	0.596322	1.51632	4.34484	10.935	17:00
60	1.458	0.488	1.35	2.87	7.9	0.711504	1.9683	4.18446	11.5182	15:00
60	1.458	0.375	0.6	1.66	7	0.54675	0.8748	2.42028	10.206	17:00
60	1.458	0.458	0.849	1.46	6.1	0.667764	1.237842	2.12868	8.8938	13:20
60	1.458	0.288	0.552	1.71	5	0.419904	0.804816	2.49318	7.29	15:20
				Flux	Flood	-0.61	-1.08	1.9	8.19	

APPENDIX D. (cont.)

c. Bank Site, C-3.

		Conc. (μg-at l^{-1})				Mass (μg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.378	1.47	1.22	7.7	0.275562	1.07163	0.88938	5.6133	9:00
10	0.729	0.413	1.18	1.77	7.4	0.301077	0.86022	1.29033	5.3946	11:00
10	0.729	0.399	0.477	0.587	7	0.290871	0.347733	0.427923	5.103	13:00
10	0.729	0.216	0.098	0.523	3.4	0.157464	0.071442	0.381267	2.4786	15:00
10	0.729	0.202	0.052	0.259	3.6	0.147258	0.037908	0.188811	2.6244	17:00
20	0.729	0.447	1.59	2.29	7.8	0.325863	1.15911	1.66941	5.6862	11:00
20	0.729	0.379	0.429	0.337	6.4	0.276291	0.312741	0.245673	4.6656	13:00
20	0.729	0.238	0.078	0.149	3	0.173502	0.056862	0.108621	2.187	15:00
20	0.729	0.23	0.056	0.251	3.3	0.16767	0.040824	0.182979	2.4057	17:00
40	1.458	0.548	0.414	3.26	4.8	0.798984	0.603612	4.75308	6.9984	13:00
40	1.458	0.409	0.52	0.413	4.7	0.596322	0.75816	0.602154	6.8526	15:00
40	1.458	0.37	0.441	1.5	4.5	0.53946	0.642978	2.187	6.561	17:00
60	1.458	0.416	0.402	0.788	5	0.606528	0.586116	1.148904	7.29	13:00
60	1.458	0.441	0.515	0.653	4.8	0.642978	0.75087	0.952074	6.9984	15:00
60	1.458	0.326	0.431	1.08	4.5	0.475308	0.628398	1.57464	6.561	17:00
80	1.458	0.478	0.532	0.886	4.4	0.696924	0.775656	1.291788	6.4152	15:00
80	1.458	0.283	0.311	0.636	3.7	0.412614	0.453438	0.927288	5.3946	17:00
100	1.458	0.638	1.85	1.27	7.8	0.930204	2.6973	1.85166	11.3724	15:00
100	1.458	0.339	0.448	1.25	4.5	0.494262	0.653184	1.8225	6.561	17:00
				Flux	Flood	1.47	0.40	3.59	17.39	

APPENDIX D. (cont.)

3. No Man's Friend

d. Bank Site, C-4.

		Conc. (μg-at l^{-1})				Mass (μg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.326	1.16	1.15	5.5	0.237654	0.84564	0.83835	4.0095	9:00
10	0.729	0.577	0.223	0.582	3.9	0.420633	0.162567	0.424278	2.8431	11:00
10	0.729	0.351	0.085	0.786	3.5	0.255879	0.061965	0.572994	2.5515	13:00
10	0.729	0.31	0.08	0.149	4.1	0.22599	0.05832	0.108621	2.9889	15:00
10	0.729	0.257	0.079	0.359	3.3	0.187353	0.057591	0.261711	2.4057	17:00
20	0.729	0.372	0.953	1.51	7.1	0.271188	0.694737	1.10079	5.1759	9:00
20	0.729	0.487	1.6	0.904	8.8	0.355023	1.1664	0.659016	6.4152	11:00
20	0.729	0.376	0.074	1.67	3.7	0.274104	0.053946	1.21743	2.6973	13:00
20	0.729	0.319	0.07	0.057	2.9	0.232551	0.05103	0.041553	2.1141	15:00
20	0.729	0.378	0.072	0.328	3.6	0.275562	0.052488	0.239112	2.6244	17:00
40	1.458	0.294	0.104	0.448	3.5	0.428652	0.151632	0.653184	5.103	13:00
40	1.458	0.381	0.108	0.458	3.7	0.555498	0.157464	0.667764	5.3946	15:00
40	1.458	0.276	0.061	0.337	3.5	0.402408	0.088938	0.491346	5.103	17:00
60	1.458	0.301	0.087	0.3	3.6	0.438858	0.126846	0.4374	5.2488	13:00
60	1.458	0.465	1.81	1.26	7.5	0.67797	2.63898	1.83708	10.935	15:00
60	1.458	0.394	1.58	2.07	7.1	0.574452	2.30364	3.01806	10.3518	17:00
				Flux	Flood	0.61	1.07	2.67	10.26	

APPENDIX D. (cont.)

3. No Man's Friend

e. Creek Site, C-5.

		Conc. (μg-at l^{-1})				Mass (μg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.313	1.58	1.05	6.8	0.228177	1.15182	0.76545	4.9572	9:00
10	0.729	0.422	0.223	1.17	3.22	0.307638	0.162567	0.85293	2.34738	11:00
10	0.729	0.208	0.073	0.43	5.1	0.151632	0.053217	0.31347	3.7179	13:00
10	0.729	0.244	0.052	0.234	4.3	0.177876	0.037908	0.170586	3.1347	15:00
10	0.729	0.223	0.069	0.26	4.3	0.162567	0.050301	0.18954	3.1347	17:00
20	0.729	0.404	1.5	0.715	5.9	0.294516	1.0935	0.521235	4.3011	9:00
20	0.729	0.363	1.56	1.55	8.2	0.264627	1.13724	1.12995	5.9778	11:00
20	0.729	0.218	0.058	0.209	4.1	0.158922	0.042282	0.152361	2.9889	13:00
20	0.729	0.221	0.106	0.209	4.5	0.161109	0.077274	0.152361	3.2805	15:00
20	0.729	0.272	0.138	0.272	4.5	0.198288	0.100602	0.198288	3.2805	17:00
40	1.458	0.453	1.49	2.15	7.6	0.660474	2.17242	3.1347	11.0808	11:00
40	1.458	0.24	0.063	0.289	4.2	0.34992	0.091854	0.421362	6.1236	13:00
40	1.458	0.21	0.083	0.254	3.7	0.30618	0.121014	0.370332	5.3946	15:00
40	1.458	0.21	0.046	0.199	4.1	0.30618	0.067068	0.290142	5.9778	17:00
60	1.458	0.252	1.19	0.833	5.7	0.367416	1.73502	1.214514	8.3106	13:00
60	1.458	0.203	0.06	0.126	3.6	0.295974	0.08748	0.183708	5.2488	15:00
60	1.458	0.195	0.05	0.257	4.4	0.28431	0.0729	0.374706	6.4152	17:00
80	1.458	0.21	0.06	0.15	4.5	0.30618	0.08748	0.2187	6.561	15:00
80	1.458	0.185	0.082	0.213	4.1	0.26973	0.119556	0.310554	5.9778	17:00
100	1.458	0.398	2.12	1.66	7.4	0.580284	3.09096	2.42028	10.7892	15:00
100	1.458	0.167	0.064	0.323	4.2	0.243486	0.093312	0.470934	6.1236	17:00
120	1.458	0.555	2.33	1.68	8.2	0.80919	3.39714	2.44944	11.9556	15:00
120	1.458	0.401	3.24	1.37	8.1	0.584658	4.72392	1.99746	11.8098	17:00
				Flux	Flood	-5.83	1.60	-1.18	21.30	

APPDNDIX D. (cont.)

3. No Man's Friend

f. Creek Site, C-6.

		Conc. (μg-at l^{-1})				Mass (μg-at)				
cm	Liters	PO4	NO3	NH4	DOC	PO4	NO3	NH4	DOC	Time
10	0.729	0.388	1.58	1.05	9.6	0.282852	1.15182	0.76545	6.9984	9:00
10	0.729	0.304	1.23	1.99	6.3	0.221616	0.89667	1.45071	4.5927	11:00
10	0.729	0.326	0.128	0.276	3.5	0.237654	0.093312	0.201204	2.5515	13:00
10	0.729	0.326	0.446	0.553	5.6	0.237654	0.325134	0.403137	4.0824	15:00
10	0.729	0.282	0.092	0.286	4.7	0.205578	0.067068	0.208494	3.4263	17:00
20	0.729	0.356	1.29	0.799	6.3	0.259524	0.94041	0.582471	4.5927	9:00
20	0.729	0.401	1.77	1.26	8.1	0.292329	1.29033	0.91854	5.9049	11:00
20	0.729	0.277	0.458	0.689	4.8	0.201933	0.333882	0.502281	3.4992	13:00
20	0.729	0.345	0.574	0.866	6.4	0.251505	0.418446	0.631314	4.6656	15:00
20	0.729	0.236	0.09	0.265	4.7	0.172044	0.06561	0.193185	3.4263	17:00
40	1.458	0.401	1.33	1.66	6.6	0.584658	1.93914	2.42028	9.6228	11:00
40	1.458	0.233	0.882	1.18	5.7	0.339714	1.285956	1.72044	8.3106	13:00
40	1.458	0.217	0.1	0.26	4.5	0.316386	0.1458	0.37908	6.561	15:00
40	1.458	0.236	0.074	0.283	4.4	0.344088	0.107892	0.412614	6.4152	17:00
60	1.458	0.357	1.51	1.87	8.5	0.520506	2.20158	2.72646	12.393	13:00
60	1.458	0.366	0.241	0.448	4.8	0.533628	0.351378	0.653184	6.9984	15:00
60	1.458	0.236	0.108	0.259	4.6	0.344088	0.157464	0.377622	6.7068	17:00
80	1.458	0.379	1.16	1.21	6.1	0.552582	1.69128	1.76418	8.8938	15:00
80	1.458	0.217	0.079	0.373	3.8	0.316386	0.115182	0.543834	5.5404	17:00
100	1.458	0.326	0.842	0.828	4.5	0.475308	1.227636	1.207224	6.561	15:00
100	1.458	0.262	0.74	1.3	5.3	0.381996	1.07892	1.8954	7.7274	17:00
120	1.458	0.355	2.34	1.08	6.9	0.51759	3.41172	1.57464	10.0602	15:00
				Flux	Flood	-33.42	0.80	0.38	21.18	

APPENDIX E. Summary of Nutrient Flux in North Inlet, by Site. Values are in μg m^{-2} $tide^{-1}$.

1. Oyster Landing

	MARSH			BANK			CREEK		
	EBB	FLOOD	NET	EBB	FLOOD	NET	EBB	FLOOD	NET
PO4	4.368	9.064	13.432	4.668	6.551	11.219	1.639	22.873	24.512
	-0.2838	17.69	17.4062	0.312	7.466	7.778	0.481	22.266	22.747
sum	4.0842	26.754	30.8382	4.98	14.017	18.997	2.12	45.139	47.259
NO3	-2.134	9.721	7.587	2.446	8.025	10.471	-13.437	13.123	-0.314
	-0.65	6.77	6.12	2.622	3.746	6.368	-13.961	-9.09	-23.051
sum	-2.784	16.491	13.707	5.068	11.771	16.839	-27.398	4.033	-23.365
NH4	12.989	55.538	68.527	20.423	22.154	42.577	-7.366	66.633	59.267
	20.86	218.46	239.32	25.603	0.452	26.055	-4.512	34.172	29.66
sum	33.849	273.998	307.847	46.026	22.606	68.632	-11.878	100.805	88.927
DOC	21.183	236.605	257.788	115.505	183.049	298.554	45.163	112.707	157.87
	50.76	284.17	334.93	55.956	39.168	95.124	29.576	133.49	163.066
sum	71.943	520.775	592.718	171.461	222.217	393.678	74.739	246.197	320.936

APPENDIX E. (cont.)

2. Town Creek

	MARSH			BANK			CREEK		
	EBB	FLOOD	NET	EBB	FLOOD	NET	EBB	FLOOD	NET
PO4	-1.239	3.9	2.661	1.499	10.403	11.902	-1.67	11.62	9.95
	0.971	7.74	8.711	1.33	8.86	10.19	5.87	10.69	16.56
sum	-0.268	11.64	11.372	2.829	19.263	22.092	4.2	22.31	26.51
NO3	0.46	2.22	2.68	0.541	2.032	2.573	1.51	1.06	2.57
	0.792	0.46	1.252	0.28	2.06	2.34	0.09	1.69	1.78
sum	1.252	2.68	3.932	0.821	4.092	4.913	1.6	2.75	4.35
NH4	0.21	6.64	6.85	36.37	9.891	46.261	-0.6	-4.43	-5.03
	-1.459	-0.17	-1.629	-3.27	5.46	2.19	-3.44	2.95	-0.49
sum	-1.249	6.47	5.221	33.1	15.351	48.451	-4.04	-1.48	-5.52
DOC	8.393	64.05	72.443	28.377	107.512	135.889	106.31	183.45	289.76
	59.151	36.99	96.141	49.56	139.88	189.44	125.1	168.26	293.36
sum	67.544	101.04	168.584	77.937	247.392	325.329	231.41	351.71	583.12

APPENDIX E. (cont.)

3. No Man's Friend

	MARSH			BANK			CREEK		
	EBB	FLOOD	NET	EBB	FLOOD	NET	EBB	FLOOD	NET
PO4	-6.295	-0.223	-6.518	4.53	1.47	6	-30.154	30.055	-0.099
	-22.182	-0.606	-22.788	5.849	17.86	23.709	-79.135	148.078	68.943
sum	-28.477	-0.829	-29.306	10.379	19.33	29.709	-109.289	178.133	68.844
NO3	4.081	-1.612	2.469	2.11	0.4	2.51	-10.871	13.333	2.462
	-0.636	-1.084	-1.72	-1.105	1.71	0.605	-10.959	14.58	3.621
sum	3.445	-2.696	0.749	1.005	2.11	3.115	-21.83	27.913	6.083
NH4	-28.137	-3.784	-31.921	-21.46	3.59	-17.87	-2.629	135.209	132.58
	-279.73	1.898	-277.832	-12.851	-0.14	-12.991	-434.84	662.095	227.255
sum	-307.867	-1.886	-309.753	-34.311	3.45	-30.861	-437.469	797.304	359.835
DOC	-45.563	-11.79	-57.353	26.38	17.39	43.77	-91.725	93.123	1.398
	-45.563	8.193	-37.37	8.807	163.07	171.877	-94.322	104.714	10.392
sum	-353.43	-13.676	-367.106	-7.931	20.84	12.909	-529.194	890.427	361.233

APPENDIX F. NUTRIENT FLUX FROM ADVECTIVE FLUX CHAMBERS, by site.

1. Oyster Landing

Marsh 1	Volume (L)	Conc. (µg-at l^{-1})	Mass (µg-at)	Time (hrs.)	Net Flux (µg-at m^{-2} $tide^{-1}$)
PO4	0.052	0.124	0.006448	1:14	0.03157689
	0.052	0.127	0.006604	1:14	0.03234084
NO3	0.052	2.78	0.14456	1:14	0.7079334
	0.052	2.98	0.15496	1:14	0.75886386
NH4	0.052	10.8	0.5616	1:14	2.75024486
	0.052	9.27	0.48204	1:14	2.36062684
DOC	0.052	6.6	0.3432	1:14	1.68070519
	0.052	7.2	0.3744	1:14	1.83349657

Marsh 2	Volume (L)	Conc. (µg-at l^{-1})	Mass (µg-at)	Time (hrs.)	Net Flux (µg-at m^{-2} $tide^{-1}$)
PO4	0.008	1	0.008	3:10	0.03917728
NO3	0.008	1.77	0.01416	3:10	0.06934378
NH4	0.008	29.4	0.2352	3:10	1.15181195
DOC	0.008	7.4	0.0592	3:10	0.28991185

APPENDIX F. (cont.)

Marsh 3	Volume (L)	Conc. (µg-at l^{-1})	Mass (µg-at)	Time (hrs.)	Net Flux (µg-at m^{-2} $tide^{-1}$)
PO4	0.01	0.159	0.00159	5:21	0.00778648
NO3	0.01	0.791	0.00791	5:21	0.03873653
NH4	0.01	29.8	0.298	5:21	1.45935357
DOC	0.01	7.2	0.072	5:21	0.35259549

Bank 1	Volume (L)	Conc. (µg-at l^{-1})	Mass (µg-at)	Time (hrs.)	Net Flux (µg-at m^{-2} $tide^{-1}$)
PO4	0.062	0.931	0.057722	1:05	0.28267385
NO3	0.062	0.718	0.044516	1:05	0.21800196
NH4	0.062	3.83	0.23746	1:05	1.16287953
DOC	0.062	0	0	1:05	0

Bank 2	Volume (L)	Conc. (µg-at l^{-1})	Mass (µg-at)	Time (hrs.)	Net Flux (µg-at m^{-2} $tide^{-1}$)
PO4	0.094	0.0829	0.007793	3:01	0.03816161
	0.094	0.0655	0.006157	3:01	0.03015181
NO3	0.094	1.57	0.14758	3:01	0.72272282
	0.094	1.14	0.10716	3:01	0.52477963
NH4	0.094	8.42	0.79148	3:01	3.87600392
	0.094	6.46	0.60724	3:01	2.97375122
DOC	0.094	11.3	1.0622	3:01	5.20176298
	0.094	8.7	0.8178	3:01	4.00489716

APPENDIX F. (cont.)

Bank 3	Volume (L)	Conc. (µg-at l^{-1})	Mass (µg-at)	Time (hrs.)	Net Flux (µg-at m^{-2} $tide^{-1}$)
PO4	0.03	0.856	0.02568	5:33	0.12575906
NO3	0.03	0.381	0.01143	5:33	0.05597453
NH4	0.03	1.08	0.0324	5:33	0.15866797
DOC	0.03	6.6	0.198	5:33	0.96963761

Creek 1	Volume (L)	Conc. (µg-at l^{-1})	Mass (µg-at)	Time (hrs.)	Net Flux (µg-at m^{-2} $tide^{-1}$)
PO4	0.062	0.132	0.008184	11:14	0.04007835
	0.062	0.171	0.010602	11:14	0.05191969
NO3	0.062	6.34	0.39308	11:14	1.92497551
	0.062	7.23	0.44826	11:14	2.19520078
NH4	0.062	5.34	0.33108	11:14	1.62135162
	0.062	5.59	0.34658	11:14	1.69725759
DOC	0.062	18.9	1.1718	11:14	5.73849167
	0.062	17.2	1.0664	11:14	5.22233105

APPENDIX F. (cont.)

Creek 2	Volume (L)	Conc. (μg-at l^{-1})	Mass (μg-at)	Time (hrs.)	Net Flux (μg-at m^{-2} $tide^{-1}$)
PO4	0.025	0.178	0.00445	1:27	0.02179236
NO3	0.025	1.68	0.042	1:27	0.20568071
NH4	0.025	4.88	0.122	1:27	0.59745348
DOC	0.025	16.1	0.4025	1:27	1.97110676

Creek 3	Volume (L)	Conc. (μg-at l^{-1})	Mass (μg-at)	Time (hrs.)	Net Flux (μg-at m^{-2} $tide^{-1}$)
PO4	0.165	0.115	0.018975	3:23	0.0929236
	0.165	0.112	0.01848	3:23	0.09049951
NO3	0.165	1.24	0.2046	3:23	1.00195886
	0.165	0.945	0.155925	3:23	0.76358962
NH4	0.165	11.7	1.9305	3:23	9.4539667
	0.165	14.8	2.442	3:23	11.9588639
DOC	0.165	15.7	2.5905	3:23	12.6860921
	0.165	17.9	2.9535	3:23	14.463761

APPENDIX F. (cont.)

Creek 4	Volume (L)	Conc. (µg-at l^{-1})	Mass (µg-at)	Time (hrs.)	Net Flux (µg-at m^{-2} $tide^{-1}$)
PO4	0.07	0.159	0.01113	5:05	0.05450539
	0.07	0.123	0.00861	5:05	0.04216454
NO3	0.07	1.36	0.0952	5:05	0.4662096
	0.07	1.07	0.0749	5:05	0.36679726
NH4	0.07	4.04	0.2828	5:05	1.38491675
	0.07	0.851	0.05957	5:05	0.2917238
DOC	0.07	17.2	1.204	5:05	5.89618022
	0.07	15.3	1.071	5:05	5.24485798

APPENDIX F. (cont.)

2. Town Creek

Marsh 1	Volume (L)	Conc. (µg-at l^{-1})	Mass (µg-at)	Time (hrs.)	Net Flux (µg-at m^{-2} $tide^{-1}$)
PO4	0.112	0.488	0.055	1:30	0.2677
	0.112	0.435	0.049	1:30	0.2386
NO3	0.112	0.164	0.018	1:30	0.0899
	0.112	0.139	0.015	1:30	0.0762
NH4	0.112	13.980	1.566	1:30	7.668
	0.112	12.600	1.411	1:30	6.911
DOC	0.112	4.800	0.5376	1:30	2.6327
	0.112	4.300	0.4816	1:30	2.3584

Marsh 2	Volume (L)	Conc. (µg-at l^{-1})	Mass (µg-at)	Time (hrs.)	Net Flux (µg-at m^{-2} $tide^{-1}$)
PO4	0.078	0.648	0.050544	4:10	0.247522
	0.078	1.61	0.12558	4:10	0.614985
NO3	0.078	0.819	0.063882	4:10	0.31284
	0.078	0.561	0.043758	4:10	0.21429
NH4	0.078	50.2	3.9156	4:10	19.17532
	0.078	95.4	7.4412	4:10	36.44074
DOC	0.078	10.8	0.8424	4:10	4.125367
	0.078	16.3	1.2714	4:10	6.226249

APPENDIX F. (cont.)

Bank 1	Volume (L)	Conc. (µg-at l^{-1})	Mass (µg-at)	Time (hrs.)	Net Flux (µg-at m^{-2} $tide^{-1}$)
PO4	0.083	0.834	0.069222	1:20	0.338991
	0.083	0.765	0.063495	1:20	0.310945
NO3	0.083	0.311	0.025813	1:20	0.12641
	0.083	0.321	0.026643	1:20	0.130475
NH4	0.083	6.98	0.57934	1:20	2.83712
	0.083	7.29	0.60507	1:20	2.963124
DOC	0.083	4.4	0.3652	1:20	1.788443
	0.083	4.7	0.3901	1:20	1.910382

Bank 2	Volume (L)	Conc. (µg-at l^{-1})	Mass (µg-at)	Time (hrs.)	Net Flux (µg-at m^{-2} $tide^{-1}$)
PO4	0.054	2.05	0.1107	3:30	0.542116
	0.054	1.45	0.0783	3:30	0.383448
NO3	0.054	0.501	0.027054	3:30	0.132488
	0.054	0.24	0.01296	3:30	0.063467
NH4	0.054	25.6	1.3824	3:30	6.769833
	0.054	18.18	0.98172	3:30	4.80764
DOC	0.054	5.3	0.2862	3:30	1.401567
	0.054	3.6	0.1944	3:30	0.952008

APPENDIX F. (cont.)

Creek 1	Volume (L)	Conc. (μg-at l^{-1})	Mass (μg-at)	Time (hrs.)	Net Flux (μg-at m^{-2} $tide^{-1}$)
PO4	0.149	2175	324.075	1:00	1587.047
	0.149	2890	430.61	1:00	2108.766
NO3	0.149	1.18	0.17582	1:00	0.861019
	0.149	1.27	0.18923	1:00	0.92669
NH4	0.149	53.8	8.0162	1:00	39.25661
	0.149	62.2	9.2678	1:00	45.3859
DOC	0.149	4.1	0.6109	1:00	2.991675
	0.149	4.5	0.6705	1:00	3.283546

Creek 2	Volume (L)	Conc. (μg-at l^{-1})	Mass (μg-at)	Time (hrs.)	Net Flux (μg-at m^{-2} $tide^{-1}$)
PO4	0.076	1.02	0.07752	3:00	0.379628
	0.076	1.1	0.0836	3:00	0.409403
NO3	0.076	0.326	0.024776	3:00	0.121332
	0.076	0.266	0.020216	3:00	0.099001
NH4	0.076	15.88	1.20688	3:00	5.910284
	0.076	17.34	1.31784	3:00	6.453673
DOC	0.076	3.2	0.2432	3:00	1.190989
	0.076	3.1	0.2356	3:00	1.153771

APPENDIX F. (cont.)

3. No Man's Friend

Marsh 1	Volume (L)	Conc. (μg-at l^{-1})	Mass (μg-at)	Time (hrs.)	Net Flux (μg-at m^{-2} $tide^{-1}$)
PO4	0.018	1.59	0.02862	4:37	0.140157
NO3	0.018	16.2	0.2916	4:37	1.428012
NH4	0.018	12.6	0.2268	4:37	1.110676
DOC	0.018	9.3	0.1674	4:37	0.819785

Bank 1	Volume (L)	Conc. (μg-at l^{-1})	Mass (μg-at)	Time (hrs.)	Net Flux (μg-at m^{-2} $tide^{-1}$)
PO4	0.026	1.36	0.03536	4:34	0.173164
NO3	0.026	1.82	0.04732	4:34	0.231734
NH4	0.026	68.6	1.7836	4:34	8.734574
DOC	0.026	8.2	0.2132	4:34	1.044074

APPENDIX F. (cont.)

Bank 2	Volume (L)	Conc. (μg-at l^{-1})	Mass (μg-at)	Time (hrs.)	Net Flux (μg-at m^{-2} $tide^{-1}$)
PO4	0.018	1.45	0.0261	6:30	0.127816
NO3	0.018	15.2	0.2736	6:30	1.339863
NH4	0.018	14.08	0.25344	6:30	1.241136
DOC	0.018	10	0.18	6:30	0.881489

Creek 1	Volume (L)	Conc. (μg-at l^{-1})	Mass (μg-at)	Time (hrs.)	Net Flux (μg-at m^{-2} $tide^{-1}$)
PO4	0.024	0.583	0.013992	12:30	0.068521
NO3	0.024	10.5	0.252	12:30	1.234084
NH4	0.024	40.8	0.9792	12:30	4.795299
DOC	0.024	8.1	0.1944	12:30	0.952008

Creek 2	Volume (L)	Conc. (μg-at l^{-1})	Mass (μg-at)	Time (hrs.)	Net Flux (μg-at m^{-2} $tide^{-1}$)
PO4	0.041	0.561	0.023001	2:30	0.11264
NO3	0.041	1.85	0.07585	2:30	0.37145
NH4	0.041	25.6	1.0496	2:30	5.140059
DOC	0.041	2.3	0.0943	2:30	0.461802

APPENDIX F. (cont.)

Creek 3	Volume (L)	Conc. (µg-at l^{-1})	Mass (µg-at)	Time (hrs.)	Net Flux (µg-at m^{-2} $tide^{-1}$)
PO4	0.069	1.36	0.09384	4:35	0.459549
NO3	0.069	1.82	0.12558	4:35	0.614985
NH4	0.069	31	2.139	4:35	10.47502
DOC	0.069	2	0.138	4:35	0.675808

Creek 4	Volume (L)	Conc. (µg-at l^{-1})	Mass (µg-at)	Time (hrs.)	Net Flux (µg-at m^{-2} $tide^{-1}$)
PO4	0.02	1.04	0.0208	6:32	0.101861
NO3	0.02	2.24	0.0448	6:32	0.219393
NH4	0.02	91.8	1.836	6:32	8.991185
DOC	0.02	11.2	0.224	6:32	1.096964

APPENDIX G. SAS Programs For Nutrient Flux Analyses.

1. Oyster Landing

```
TITLE "ANOVA OF NORTH INLET NUTRIENT
FLUX, Oyster Landing";
OPTIONS LS=80;
DATA FX;
INFILE FXO OBS=6;
INPUT S$ DR$ P NO NH C;
PROC ANOVA DATA=FX;
CLASS S DR;
MODEL P NO NH C = S DR S*DR;
MEANS S DR/T SNK SCHEFFE;
/*
//
```

2. Town Creek

```
TITLE "ANOVA OF NORTH INLET NUTRIENT
FLUX, Town Creek";
OPTIONS LS=80;
DATA FX;
INFILE FXT OBS=6;
INPUT S$ DR$ P NO NH C;
PROC ANOVA DATA=FX;
CLASS S DR;
MODEL P NO NH C = S DR S*DR;
MEANS S DR/T SNK SCHEFFE;
/*
//
```

3. No Man's Friend

```
TITLE "ANOVA OF NORTH INLET NUTRIENT
FLUX, No Man's Friend";
OPTIONS LS=80;
DATA FX;
INFILE FXN OBS=6;
INPUT S$ DR$ P NO NH C;
PROC ANOVA DATA=FX;
CLASS S DR;
MODEL P NO NH C = S DR S*DR;
MEANS S DR/T SNK SCHEFFE;
/*
//
```

4. All three sites.

```
TITLE "ANOVA OF NORTH INLET NUTRIENT
FLUX, All Three Sites";
OPTIONS LS=80;
DATA FX;
INFILE FXALL OBS=18;
INPUT L$ S$ DR$ P NO NH C;
PROC ANOVA DATA=FX;
CLASS L S DR;
MODEL P NO NH C = L S DR L*S*DR L*S L*D D*S;
MEANS L S DR/T SNK SCHEFFE;
/*
//
```

APPENDIX G. (cont.)

5. All three sites, Phosphorus.

```
TITLE "ANOVA OF NORTH INLET NUTRIENT
FLUX, All Three Sites, Phosphorus";
OPTIONS LS=80;
DATA FX;
INFILE FXALL OBS=18;
INPUT L$ S$ DR$ P NO NH C;
PROC ANOVA DATA=FX;
CLASS L S DR;
MODEL P = L S DR L*S*DR L*S L*D D*S;
MEANS L S DR/T SNK SCHEFFE;
/*
//
```

6. All three sites, Nitrate.

```
TITLE "ANOVA OF NORTH INLET NUTRIENT
FLUX, All Three Sites, Nitrate";
OPTIONS LS=80;
DATA FX;
INFILE FXALL OBS=18;
INPUT L$ S$ DR$ P NO NH C;
PROC ANOVA DATA=FX;
CLASS L S DR;
MODEL NO = L S DR L*S*DR L*S L*D D*S;
MEANS L S DR/T SNK SCHEFFE;
/*
//
```

7. All three sites, Ammonia.

```
TITLE "ANOVA OF NORTH INLET NUTRIENT
FLUX, All Three Sites, Ammonia";
OPTIONS LS=80;
DATA FX;
INFILE FXALL OBS=18;
INPUT L$ S$ DR$ P NO NH C;
PROC ANOVA DATA=FX;
CLASS L S DR;
MODEL NH = L S DR L*S*DR L*S L*D D*S;
MEANS L S DR/T SNK SCHEFFE;
/*
//
```

8. All three sites, Carbon.

```
TITLE "ANOVA OF NORTH INLET NUTRIENT
FLUX, All Three Sites, Carbon";
OPTIONS LS=80;
DATA FX;
INFILE FXALL OBS=18;
INPUT L$ S$ DR$ P NO NH C;
PROC ANOVA DATA=FX;
CLASS L S DR;
MODEL C = L S DR L*S*DR L*S L*D D*S;
MEANS L S DR/T SNK SCHEFFE;
/*
//
```